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Littoral Combat Ships

In Action®

John Gourley

Squadron Signal® Publications

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Written by John Gourley

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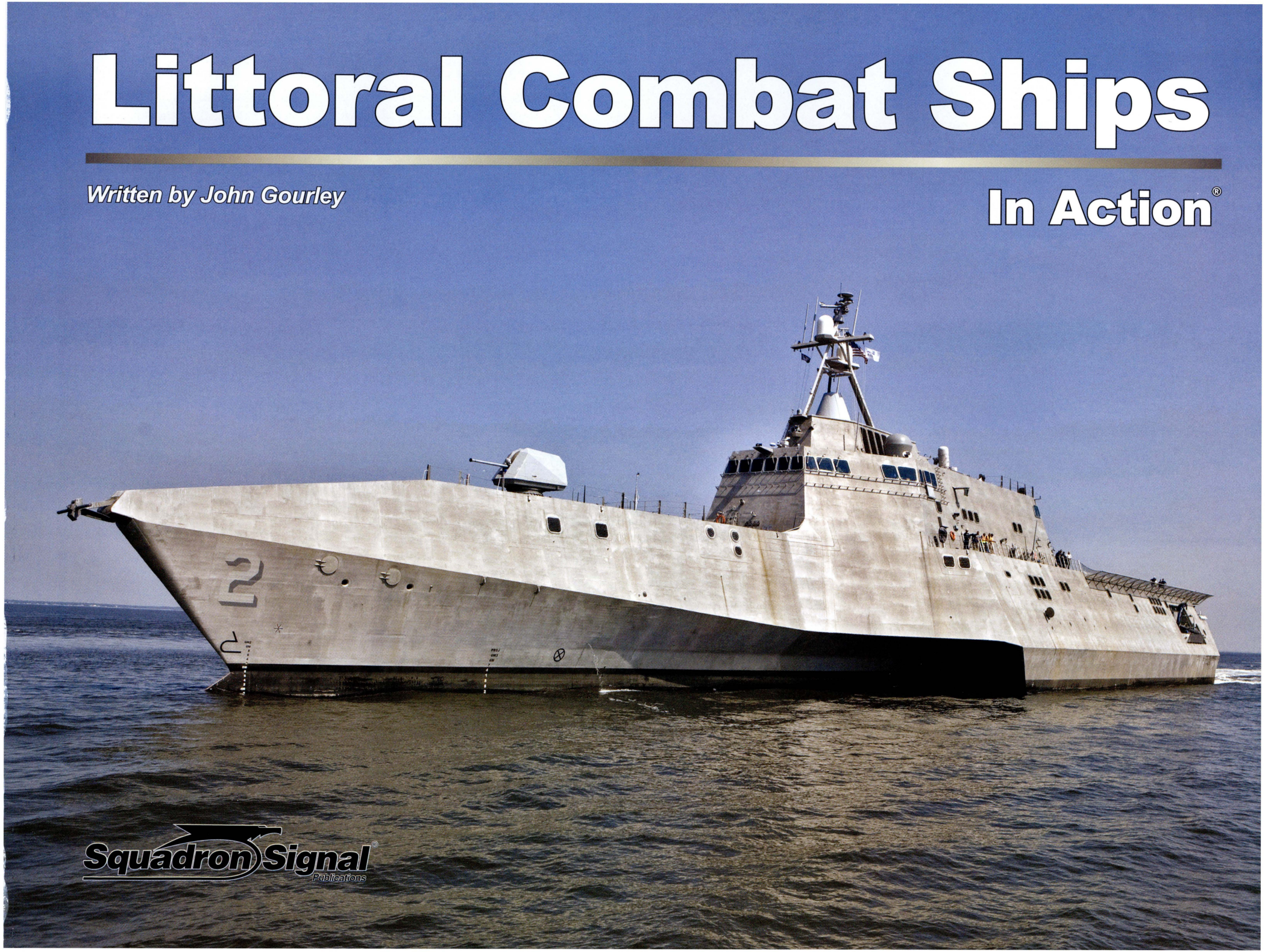

Squadron Signal® Publications

(Front Cover) LCS-1 *Freedom* is underway at high speed during builder's trials in February 2013. (Lockheed Martin)

(Back Cover) LCS-2 *Independence* underway during maneuvering trials in the Gulf of Mexico in July 2009. (Dennis Griggs/General Dynamics)

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(Title Page) LCS-2 *Independence* underway during builder's trials in the Gulf of Mexico in July of 2009. (Dennis Griggs / General Dynamics)

Acknowledgments

To Lou Drendel – for his assistance in getting me started. To A.D. Baker III – for his help (and reams of LCS historical data) I was able to include in this book. To Robert F. Dorr – for his inspiration and encouragement. To Dr. Norman Friedman – for his insights on many technical issues.

Dedication

To my Daughter Jacqueline – for her encouragement and support. To all Littoral Combat Ship crews – working hard in perfecting techniques of littoral warfare, A critical mission in the overall objective of defending the freedom of the seas.

Introduction

The need for littoral combat ships (LCS)

With the end of the Cold War Era and naval action in the First Gulf War, Operation Desert Storm, in the early 1990s, the Navy recognized a requirement for small, fast vessels capable of operating in the littoral regions of the globe where future conflicts were likely to occur.

The word littoral (from the Latin littoralis – "of or belonging to the seashore") refers to the shallow environment of a lake, sea or ocean. It is for these very areas that the new type of ship would be designed and where it would be expected to operate, survive and prevail.

In prior decades the United States Navy had been designed around deep ocean "blue-water" operations as a counter to the vast Soviet Navy in order to keep sea lines of communication open in times of crisis. The collapse of the Soviet Union meant that future conflicts were likely to involve smaller, regional adversaries with more localized, though still potent, naval potentials. Larger vessels are vulnerable in the littorals due to deep drafts, hull size, and restricted maneuverability. Naval strategists were therefore reluctant to send such ships into littoral regions, so a new ship was needed to fill this gap in the planned strategy of littoral warfare in order to be influential in such waters.

The new ship would therefore be small and fast, with a crew complement of around 40 and capable of deploying a helicopter, sweeping areas for mines and, with a shallow draft, able to operate unencumbered in the so called shallow "brown-water" regions of the globe. The ship would deal with hostile forces attempting to leave port, to head out to sea to engage vessels offshore such as amphibious assault ships, logistic support vessels, and aircraft carriers. Self-defense would also be part of the requirement for the new U.S. vessel, as the ship would, by nature of its mission, be more exposed to hostile forces on land than to larger vessels that would be better armed, but could not function effectively in shallow coastal areas.

The ships would also be built from the outset to be electronically linked into the overall surface combatant force structure so that aspects of operations while underway could be monitored, interrogated and analyzed, and acted upon by other friendly assets if necessary. Sensors also would stream data on ship performance and health. If an issue were discovered, the crew could be advised of actions to take to maintain required efficiency. With such modern technology, LCS would be cheaper to upgrade over the service life of the class. With several older classes of ship, the Navy had found it more economical to retire them and build new ships rather than initiate one or more costly upgrade programs.

Another side benefit would be that in peacetime the new-type vessel could access more ports, conduct covert intelligence-surveillance-reconnaissance (ISR) missions, gather information on littoral activities, plant unattended sensors to continue collecting data, map undersea terrain in shallow areas of interest, and show the flag or offer humanitarian assistance in areas that larger ships could not enter. In the event of a future crisis in an area of tension, the accumulated information would be used to great advantage when planning tactical operations.

The first serious consideration of an LCS platform was in late 2001, when the Office of Naval Research – ONR, was discussing a preliminary ship design with a displacement of 500 to 600 tons, a speed of 50-60 knots, a range of 4,000 nautical miles, and a draft of 10 feet. Such a ship was expected to cost about $90 million each in 2001 dollars, a fraction of the cost of the larger ships being built at that time. Such a ship, given the label Streetfighter, would be produced in numbers to eventually total up to one quarter of the size of the future Navy surface fleet, to a total of about 50 such ships. Streetfighter would assist Marine units in amphibious assault operations while neutralizing and clearing mines, conducting anti-submarine warfare (ASW) and anti-air warfare (AAW) operations, doing their part to keep threats in the littoral regions in check, so that the rest of the fleet could stay in the open ocean and continue in its traditional supporting roles. Any hostile reactions, such as an anti-ship missile attack against Streetfighter, would be detected by the deployed sensor network and put out of action by the larger vessels far offshore. If the Streetfighter vessels were damaged or rendered unusable as a result of combat action, they would be abandoned, since they were cheap and there would be plenty of them. With several of them involved in an operation, the loss of one or two would not be seen as a setback as the others could move in to fill any gaps in coverage.

Another line of thought was in favor of building ships like the DD-21 (21st century destroyer)/SC-21 21st century strike cruiser) design – a large, heavy ship with a wide beam but with a hull design created to operate in the shallows, armed with many Standard and Tomahawk cruise missiles, with sufficient structural armor to take hits and continue operating. The ship would incorporate stealth design, rely on co-operative engagement capability – (CEC) datalinks from other ships for targeting data, and have no other purpose than to approach shorelines and saturate the enemy with missile attacks to shoot down aircraft, intercept missiles, and destroy hostile warfighting capabilities ashore and far inland. Such a ship was estimated to cost around $750 million each and be manned by up to 200 personnel. Eventually, this concept fell into disfavor due to the cost, size of the ship/crew, and single-mission use of these vessels – features undesirable in an era of budget cutbacks and of building vessels capable of multiple tasks with smaller crews.

The entire naval war fighting concept changed after the terror attacks of 11 September 2001. Up to that time, the Navy had been configured to fight two major wars under Cold War doctrine. Now it was faced with the reality of fighting two or more smaller actions simultaneously. What the Navy needed to implement was a strategy where several expeditionary groups could respond effectively to a 4-2-1 scenario; handling four crises around the world while influencing favorable outcomes in two regional actions, and being a strong factor to win in one major war. In this new state of affairs, the Navy in 2003 committed to the $15 billion LCS program that formally dispensed with the DD-21/SC-21 concept and launched what is now known as the LCS class of naval vessels.

In that same year, Lockheed Martin, Northrop Grumman, Raytheon, and General Dynamics submitted their design proposals for the new ship. It was also realized that the new class should eventually replace and perform the functions of the Cyclone patrol combatant, *Avenger*-class minesweepers and *Oliver Hazard Perry*-frigate classes of ships

LCS-1 *Freedom* gets underway from Changi Naval Base in Singapore, to attend a cooperation afloat readiness and training or CARAT exercise in July of 2013. (Jay C. Pugh / U.S. Navy)

which were approaching their retirement dates. Months later, the Northrop Grumman design was eliminated from consideration, and the Raytheon design was dropped in 2004. Lockheed Martin and General Dynamics were left to submit their designs for evaluation.

LCS Procurement

LCS-1 was funded in fiscal year (FY) 2005. LCS-3 funded in FY-09. LCS-5 in FY-10, LCS-7 in FY-11, LCSs -9 and -11 in FY-12. Unit cost has risen from a predicted $220 million, each, to $537 million.

LCS-2 was funded in FY-06, LCS-4 in FY-09, LCS-6 in FY-11. Costs for this variant have increased from an estimated $220 million, each, to $635 million.

Four more ships were scheduled to be built in FY 12, -13, -14 with three to be built in FY-15 through -18. Two in FY-19 and three more in FY-20.

Twenty three ships from both builders are to be funded through FY-15. The Navy FY-16 budget request of $1.437 billion is for three more ships at a unit cost of $479 million each. Ship design is to Flight 0 standard, the ship itself being referred to as the LCS sea frame.

The first four ships were built under single-ship contracts. The Navy was to down-select a single builder but asked Congress in 2010 for authority to allow a dual-source acquisition of the next 20 ships, to preserve competition in the program and result in lower acquisition costs so each builder will construct 10 ships in quantities of 1-1-2-2-2-2.

The Lockheed Martin LCS are built in Marinette, Wisconsin by Marinette Marine, a subsidiary of the Fincantieri Group of which Lockheed Martin is a minor investor. The General Dynamics LCS ships are built in Mobile, Alabama, by Austal USA, a joint venture between Austal Limited of Henderson, Western Australia and Bender Shipbuilding & Repair Company of Mobile Alabama, with Austal Ltd. as the major shareholder.

Freedom-class LCS ships

Ship	Laid down	Launched	Commissioned	Fleet
LCS-1 *Freedom*	2 JUN 05	23 SEP 06	8 NOV 08	Pacific
LCS-3 *Fort Worth*	11 JUL 09	7 DEC 10	22 SEP 12	Pacific
LCS-5 *Milwaukee*	27 OCT 11	18 DEC 13	21 NOV 15	
LCS-7 *Detroit*	11 AUG 12	18 OCT 14		
LCS-9 *Little Rock*	27 JUN 13	18 JUL 15		
LCS-11 *Sioux City*	19 FEB 14			
LCS-13 *Wichita*	9 FEB 15			
LCS-15 *Billings*	2 NOV 15			
LCS-17 *Indianapolis*				
LCS-19 *St. Louis*				
LCS-21 *Minneapolis/St. Paul*				
LCS-23 *Cooperstown*				

Independence-class LCS ships

Ship	Laid down	Launched	Commissioned	Fleet
LCS-2 *Independence*	19 JAN 06	26 APR 08	16 JAN 10	Pacific
LCS-4 *Coronado*	17 DEC 09	14 JAN 12	5 APR 14	Pacific
LCS-6 *Jackson*	1 AUG 11	14 DEC 13	5 DEC 15	
LCS-8 *Montgomery*	25 JUN 13	6 AUG 14		
LCS-10 *Gabrielle Giffords*	16 APR 14	25 FEB 15		
LCS-12 *Omaha*	18 FEB 15	20 NOV 15		
LCS-14 *Manchester*	29 JUN 15			
LCS-16 *Tulsa*				
LCS-18 *Charleston*				
LCS-20 *Cincinnati*				
LCS-22 *Kansas City*				
LCS-24 *Oakland*				

LCS ship names are of cities in the United States with LCS-1 *Freedom* signifying the continuing cause that all Americans hold dear. LCS-10 *Gabrielle Giffords* is named after the former Arizona Senator who was shot in January 2011 and has since made a miraculous recovery from her wounds.

LCS Mission Modules/Packages

From warships of the Danish Royal Navy LCS vessels have borrowed a useful design feature: the ability to outfit vessels with packages and modules containing the equipment, along with the specialized crews and small craft needed to accomplish a specific mission task while at sea. LCS mission modules are designed for anti-submarine warfare, mine hunting, and anti-air warfare. By following this practice, the ships can be kept smaller and lighter. These packages/modules can be pre-positioned in areas where conflict might occur, and once the LCS sea frame arrives at port, it can be fitted out in a matter of hours. Total procurement cost for these LCS mission packages is estimated at $7.24 billion for 23 mine countermeasures packages, 21 surface warfare packages, and 15 anti-submarine warfare packages. An estimated average initial procurement cost breakdown of each unit is:

$97.7 million for each mine countermeasures set, $32.6 million for each anti-submarine warfare set and $20.9 million for every surface warfare set. The price of each of 59 common mission package equipment sets that are needed to accompany a mission module/package is $14.8 million each.

The surface warfare package-module consists of: two Mk 46 30mm gun systems, with rounds powerful enough to penetrate 10 inches of concrete, two 11-meter RHIBs (rigid-hull inflatable boats) and weapons such as the AGM-114 Hellfire missile to be used by the SH-60/MH-60 helicopters or MQ-8B Fire Scout VTUAV. The XM501 NLOS-LS 25-mile range non-line-of-sight launch system missiles are also included. A single container launch unit (CLU), holds 15 missiles to be loaded into the hull of the LCS sea frame and integrated into the ship for an offensive firepower capability against inland targets. Another option might include adding the Kongsberg Defense & Aerospace 100-mile range naval strike missile or NSM. A *Freedom*-class ship could carry 12, the *Independence* class 18.

The anti-submarine or ASW module/package would be composed of: a CAPTAS 4 towed low-frequency active/passive sonar. Streamed behind the ship while it is underway, it is able to detect submarine activity and the launching of torpedoes against it. Submarines cannot use thermal layers to hide in the shallow littoral waters, making detection easier. The embarked SH/MH-60 helicopters will be provided with the Mk-54 lightweight torpedo to attack submarines. Torpedo decoys are also included to lure torpedoes away from the ship.

The first phase of the mine countermeasures module would be composed of: the WLD-1 remote mine-hunting system (RMS) consisting of the remote multi-mission vehicle (RMMV) and the AQS-20A underwater towed sonar. Also for use by the embarked helicopter is a pod designated the AN/AES-1 airborne laser mine detection system (ALMDS). ALMDS will detect floating or moored mines below the surface of the water, the RMS will be used to find mines below the surface. Once found and plotted, the mines will be neutralized by the AQS-235 AMNS, the airborne mine neutralization system, which is lowered by the helicopter and operated by a technician in order to disable mines. This mission module/package is to be declared operational in 2016.

LCS-1 *Freedom* is christened and launched. A tug with bow line stands ready to guide the ship as she settles into the water. During winter months launching activities cease due to ice buildup in the river. The final fitting out phase began the next day. (Lockheed Martin)

LCS "3-2-1" crew assignment

The LCS sea frames are built to incorporate increased automation so as to reduce crew size. The basic crew complement is to be around 40, which rises by 20 or more as additional ratings are brought aboard for the aviation department if a helicopter is in use; up to 15 more are needed to operate the mission modules, so the crew size can rise to around 90. This is still far fewer than are needed to man a frigate, cruiser, or destroyer.

Three crews will be assigned for every two LCS vessels, with one ship underway continuously. This 3-2-1 scheme will keep an LCS deployed for 16 months, with crews rotated off at four-month intervals. By way of this method, these ships will be available in greater numbers than if they were manned in traditional fashion. If a single crew was assigned to each LCS, deployments would only last for six to eight months at a time.

Waterjet propulsion system

One innovative design feature of the LCS class is the means by which the ships move under power. Waterjets were invented in 1931 but suffered from a lack of technology to make them economically viable. It was not until 1954 that a producible design was fielded. Initially used on small craft such as jet boats/jet skis and even on torpedoes, they have found much favor in modern times in ever larger watercraft such as ferries and numerous military vessels the world over. The interface of powerful engines to the waterjet configuration results in fast speeds, of which a routine value 40 knots is not an uncommon result. Hull design is not a factor as even conventional hull shapes can be used with good effect. A waterjet works in the following fashion:

A water inlet duct or intake in the hull bottom allows water to enter, where it is pushed aft through a nozzle by means of a pump of one of various designs such as a centrifugal pump for high speeds, an axial flow pump for medium speeds or an inducer for low-speed operation. The pump itself is attached to a prop-shaft and essentially looks like a conventional prop on a shaft as most ships use in the conventional manner. The difference is that the pump fits closely inside the duct, with blades or vanes cropped to conform to the duct diameter.

The nozzle (section seen protruding from the transom) can be articulated by means of hydraulic struts to provide steerage and if a ship requires a capability to reverse direction, a reversing bucket can be added. This either deploys over the water outlet nozzle to send the water stream down and aft, much like those used as thrust reversers on aircraft, or, internal ramps actuate inside the nozzle to divert the flow down and aft to either back the vessel up or help it stop in a shorter distance.

What makes waterjet systems so attractive for use in the littorals is that the inlet duct only needs to be submerged in order to operate. The rotating parts are enclosed and protected, a safety advantage for sea-life and swimmers. A big advantage when moving in shallow waters during ASW operations is the reduced noise waterjets produce. Steerable nozzles add vectored thrust to enhance maneuverability.

Disadvantages include high cost and inefficiency at low speeds compared to conventional propellers. The intake, when operating in the littoral regions, can become clogged with seaweed or aquatic plants. One simple remedy is to engage a reversing gearbox if equipped, which hopefully clears the obstruction.

In sea trials, LCS-2 *Independence* suffered considerable pitting and galvanic corrosion due to use of dissimilar metals in her construction in the area of the waterjet propulsion system water inlet ducting. This resulted in her being dry-docked to install a cathodic protection system or CPS which was verified as a fix in 2012. The CPS remedy is to be used on all future ships.

LCS ships have been built to level 1+ survivability standards including electromagnetic pulse (EMP) hardening of electrical components, chemical/biological/radiological (CBR) decontamination stations, remote and automatic fire suppression systems, armor in vital spaces, propulsion systems shock-hardened and the ability to maintain structural integrity at up to a maximum of sea state 8 conditions. Even with all of these survivability enhancements, the ships do not meet the minimum level of robustness (Level 2) used in current fleet frigates.

In May 2012, it was discussed that the two distinct LCS designs might be suited to different regions of the globe, the LCS-1 class with smaller hull footprint should be used in the Arabian Gulf, while the LCS-2-class ships with their wide beams would operate better in the Pacific Ocean areas of operations. Also in 2012 a report on LCS stated that the ships were vulnerable to everything except small, fast boats that were not armed with anti-ship missiles.

LCS-1 *Freedom* is underway in the Straits of Singapore in August of 2013. During her transit from her home port of San Diego, she participated in 7th Fleet area of responsibility (AOR) activities. Large trim tanks flank the closed transom doors that give access to the mission bay. A primary design feature of the hull shape is to deflect radar waves away from the source of the radiated energy. The hull camouflage design was created by the crew. The large white vertical stripe next to helicopter hangar door is used as a reference by pilots landing on the ship. (Karolina A. Oseguera / U.S. Navy)

LCS-10 *Gabrielle Giffords* is launched at the Austal USA Shipyard in Mobile, Alabama in February of 2015. All *Independence* class LCS ship sea frames are to be built at this facility, with all of the *Freedom*-class LCS sea frame construction to be accomplished in Marinette, Wisconsin. (U.S. Navy)

LCS-5 *Milwaukee* crashes through waves in builder's trials. Already there are changes in radome configuration. It is not unusual for ships in the same class to sport differing communications outfits. In December of 2015, LCS-5 experienced a serious combining gear propulsion system failure. (Lockheed Martin)

In 2013, it was identified that LCS is particularly vulnerable to tactical aircraft armed with standoff missiles. Lack of a robust, permanent air defense capability for the ships is cited as a design shortcoming. If a ship under attack did not have the AAW mission module aboard, and lacked coverage from an Aegis-equipped ship offshore, it would have little else on hand to fend off such attacks. The ships also have not been well protected against cyber-warfare intrusion.

In December of 2015, Secretary of Defense Ashton Carter directed the Navy to stop procurement of LCS/FF hulls to 40 total, from 52 ships, and to select a single design to be included in the FY-17 budget request. The sole design change will be carried out in FY-19. Six more ships would be built from 2017 to 2020. Other ships such as destroyers and cruisers will fill in any future shortfalls in LCS/FF coverage.

In December of 2015, while en route from Halifax, Canada, to Mayport NAS in Florida, the crew of LCS-5 *Milwaukee* discovered metal particles in the port combining gear system. Filters were cleaned and the port shaft locked as a safety precaution. A few days later, while at sea, the onboard monitoring system indicated a loss of gear oil lube pressure in the starboard combining gear. After being towed to a nearby port facility, it was found that metal filings were present again in the combining gear unit. The combining gears connect the output from the MT-30 gas turbines and of the lower RPM diesel engines to the drive shafts that provide power to the water jets.

LCS-3 *Fort Worth* cruises into the wind and maintains heading while an Army UH-60A Blackhawk lines up to attempt a landing on the flight deck during deck landing qualification trials off the coast of Hawaii in November 2014. This training allows for use of Naval ships by Army aviators in cases where they could be needed, from disaster relief, resupply, and for operations involving Army units such as Rangers or Special Operations teams. (Antonio P. Turretto Ramos / U.S. Navy)

The unobstructed topside areas where LCS-1 has its communications radomes facilitate uninterrupted sending and receiving of streams of data such as weather updates, ship diagnostic performance, television broadcasts, and e-mail traffic. The exhaust stacks for engines and generators are aft of the mast. All decks are coated with a black anti-skid compound to prevent losing foot traction when at sea. (Lockheed Martin)

LCS-1 cruises while an MH-60S Seahawk of HSC-22 "Sea Knights" conducts approach and landing qualification maneuvers in the Atlantic in September of 2009. This helicopter is an important part of the LCS mine-hunting and anti-submarine warfare package outfit. It has two T-700 series engines and can operate safely if one engine is lost. (Nathan Laird / USN)

LCS-1 at rest in Pearl Harbor. Open transom door reveals a rigid-hull inflatable boat (RHIB) inside the mission bay. MH-60 helicopter is on the flight deck. (Diana Quinlan / U.S. Navy)

LCS-3 *Fort Worth* in a head-on view as she docks at Pearl Harbor. In the photo are numerous antennas and radomes, mast configuration and navigation radar on yardarm. (Diana Quinlan / U.S. Navy)

LCS-7 *Detroit* coat of arms is packed with meaning. Past vessels using the name *Detroit* include AOE-4, a fast combat support ship in fleet use from 1970 to 2005, and CL-8, an *Omaha*-class light cruiser which saw service during the World War II. (Navy.mil)

Ship's Coat of Arms

Every warship in the United States Navy has a ship's coat of arms, designed by the crew. It can illustrate the career of the person the ship is named after, as well as to show significant events in naval history if the vessel is named after a ship that had previously used the same name. The coat of arms is a combination of designs, all of which are highly symbolic and traditional in the fleet. The LCS-7 design is explained below.

LCS-7 *Detroit* Coat of Arms

Seal – a white oval surrounded by a dark blue border edged with a gold rope. Two inscriptions: USS *Detroit* at the top, and LCS-7 at the bottom, both being set in gold.

Shield – the background is of a partial view of the flag of the city of Detroit. A yellow trident with three lightning bolts on each tine depicts the power of today's modern United States Navy. The winged tire symbolizes the long historical connection linking Detroit to the automotive industry.

Crest (above the shield) – The grouping of six stars indicates that this ship is the 6th one named after the city of Detroit. The anchor shape signifies the modern Navy, while the mine shape illustrates the mission of mine warfare. The blue and gold alternating rope at the bottom signifies the blue and gold crews that will man the ship.

Motto – The black background shows might and determination. Yellow portrays four virtues of the crew which are nobleness, goodwill, vigor, and magnanimity. Two Mako sharks and the words *Swift Vigilance* tell of speed, preparedness, and perseverance, key to effective anti-submarine warfare.

Supporters (behind the shield) – A sword and cutlass are indicative of surface warfare and illustrate the dedication of the crew of LCS-7 *Detroit*.

Secretary of the Navy Ray Mabus addresses the crowd gathered in Marinette, Wisconsin, for the christening of LCS-7 *Detroit* on 18 October 2014. (Sam Shavers / U.S. Navy)

Seen here underway, FSF-1 *Sea Fighter* was launched in May of 2005 to conduct research with hardware intended for use at sea. It also serves to validate LCS operations, including helicopter landing, takeoff, and maintenance. It has a beam of 71 feet. (Naval Surface Warfare Center / Panama City Division)

FSF-1 passes FFG-46 *Rentz* in San Diego Harbor in August of 2005. FSF-1 is 262 feet long, weighs 1,400 tons, and has a draft of 12.5 feet. Its range at 20 knots is 4,000 nautical miles, and it has a mission bay able to load up to 12 cargo containers as mission package tests are carried out. (Naval Surface Warfare Center / Panama City Division)

FSF-1 prepares to dock in her new home port of Panama City, Florida, in February of 2012. Tapered features of her bridge and foredeck are intended to reduce radar returns. The open hatch reveals hawsepipes through which mooring lines are passed. (Naval Surface Warfare Center / Panama City Division)

Here carrying out compatibility tests with an MH-60 Seahawk, FSF-1 was the ex-X Craft IX-534. Built of aluminum, with a maximum speed of 50 knots, the ship has a crew of 16 Navy and 10 Coast Guard personnel. Power is provided by two LM-2500 gas turbines and two MTU 16V diesels. (Naval Surface Warfare Center / Panama City Division)

In this computer rendering of a *Freedom* class LCS done in May of 2004, interior views show bridge layout, combat information center, helicopter and VTUAV stored in a hangar, berthing, mission bay, and a helicopter on the flight deck. (Lockheed Martin)

LCS-1 engages in high-speed maneuvers in a rough Atlantic Ocean. An LCS specification requires these ships to have the ability to transit at high speeds to an area of conflict and once there, to begin operations immediately. The black streak on the side of the hull is from a diesel engine exhaust. The vessel's unrefueled range is 3,500 nautical miles at 14 knots. (Daniel Barker / U.S. Navy)

LCS-1 returns to Pearl Harbor after taking part in the annual RIMPAC 2011 multi-national exercise. Clearly visible is the line where the steel hull and aluminum topsides join together. Also visible under the flight deck safety netting is the mission bay side door, used to launch and recover small boats. The anchor hawsepipe location is low along the waterline at the bow. (Jon Dasbach / U.S. Navy)

LCS-1 conducts a speed run during builder's trials in August of 2008. The four waterjets are driven in a COmbined Diesel And Gas (CODAG) arrangement. The diesel or gas powerplants can be engaged separately for cruising requirements, or, in order to achieve maximum speeds, both power sources can drive the waterjet propulsion units. In addition, if one power source is down for maintenance or damaged, the other can effectively drive the ship. (Lockheed Martin)

Seaman Exammanuel Williams from the cruiser CG-70 *Lake Erie,* helps tie up LCS-1 after her arrival at Pearl Harbor. The line detail at the stem takes up the slack, and will adjust the tension if needed according to the rise or fall of the water level as a result of tidal effects. (Sean Furey / U.S. Navy)

LCS-3 *Fort Worth* departs San Diego to begin a 16-month Pacific deployment in November 2014. Black painted areas of camouflage along the mid-section of the hull hide the two diesel exhausts, which are a source of heat that an infrared sensor can detect and track. (Rosalie Chang / U.S. Navy)

LCS-1 passes Diamond Head on its way into Pearl Harbor. The ship's launch with davit are located in a large recess below the mast on the port side of hull. The port bow is clean, since the anchor hawsepipe is on starboard side. Two-tone camouflage paint makes an interesting comparison with the above image. (Johans Chavarro / U.S. Navy)

The two sets of crossed mooring lines, visible in this aerial view of LCS-1 at Pearl Harbor, are known as spring lines. They are deployed to prevent the ship from moving too far forward or aft while tied to the dock. Black shore power cables run up the mid-hull, port side, to where the plug receptacles are located. (Corey Truax / U.S. Navy)

LCS-3 sails in formation with DDG-102 *Sampson* as they both search for the missing AirAsia airliner in January of 2015. Both ships were in the vicinity and offered to scan the sea surface as well as use underwater detection equipment in an attempt to locate any wreckage. (Antonio P. Turretto Ramos / U.S. Navy)

LCS-1, is seen from CVN-74 *John C. Stennis* as the two vessels make ready for a connected refueling at sea. Surface ships may take on fuel or stores from larger ships such as aircraft carriers or amphibious assault ships, if a dedicated supply ship is unavailable. (Christopher Frost/USN)

LCS-1 cruises as an MH-60R of HSM-35 flies off the port side. Now an indispensable component of many warship classes, the helicopter performs a variety of tasks, such as conducting search and rescue missions, hunting mines and submarines, and resupply. (Joan E. Jennings / U.S. Navy)

In March of 2015, prior to the joint exercise Foal Eagle, LCS-3 makes a stop in the port of Pyeongtaek, in the Republic of Korea. The sailors of the commander, RoK 2nd Fleet, assemble to offer a formal greeting as the ship docks. South Korea and the U.S. Navy conduct routine exercises year-round. (RoK Navy)

LCS-1 *Freedom* variant, with LCS-2 *Independence* version. Both ships are radically different, sharing common weapons, internal systems, and communications links. In fleet use, one type (LCS-1) is best suited for the launching of small boats and submersible vehicles, the other (LCS-2) better able to operate assets such as unmanned aerial vehicles and helicopters. LCS-2's all-aluminum shading compares to LCS-1 with a steel hull and topsides of aluminum construction. In the lower image, LCS-1, after her maiden (1st) at-sea refueling, performs a breakaway maneuver with CVN-70 *Carl Vinson* in the distance. The breakaway is used to outrun a torpedo attack, which the LCS-1 class is capable of doing with a sprint speed of over 40 knots. Water jet propulsion is another innovation unique to both LCS types, as is the vessels' high degree of automation in all systems. By using such technology, crew size is reduced, allowing for more space for mission-module capacity, use of aviation assets, and taking on of extra personnel to operate the three interchangeable mission packages. (Lt. Jan Shultis / U.S. Navy)

LCS-3 *Fort Worth* works off the coast of Hawaii in November of 2014 with an Army UH-60Q Dustoff medevac helicopter from the 25th Combat Aviation Brigade during interoperability training. With all of the armed forces seeking to make the most use of their assets and with an emphasis on joint maneuvers, such operations become more attractive to attain the maximum use of each other's platforms. The chopper crew gains experience with approaching, landing, and taking off from a moving warship, while the vessel crew benefits from having hands-on experience with a helicopter type different from what they are used to working on. (Antonio P. Turretto Ramos / U.S. Navy)

LCS-3 sails in international waters in the South China Sea, near the disputed Spratly / Nánshā Islands, shadowed by the Frigate *Yánchéng* FFG 546 of the Chinese People's Liberation Army (Navy). This area has become one of increased tensions as many nations claim fishing and mineral rights. (Conor Minto / U.S. Navy)

In the port of Sembawang, in Singapore, a change of command ceremony is about to start on LCS-3 *Fort Worth* in May of 2015. Crews 102 and 103 assemble on the deck to take part in one of many U.S. Navy traditions as a warship in the fleet is handed over to a new captain. (Joe Bishop / U.S. Navy)

LCS-3 Gunner's Mate James Poole fires a modified M-14 rifle with a shot line at the resupply ship T-AO-197 USNS *Pecos* during a refueling at sea event. Larger lines are attached to this one and eventually a cable is hauled across so the refueling hose can be sent over. (Joe Bishop / U.S. Navy)

During a fire drill on the flight deck of LCS-3, Chief Culinary Specialist Richie Leysa gives verbal commands to two hose teams as they get ready to advance and suppress the simulated fire as instructors and evaluators look on. Such exercises keep teams skilled and help boost morale. (Antonio P. Turretto Ramos / U.S. Navy)

LCS-1 *Freedom* cruises during builder's trials in Lake Michigan in 2008. The foredeck is exceptionally clean, since most anchor hauling gear is located below decks. The red paint band around the gun is the danger area when the weapon is in operation. The white radome above bridge windows contains a commercial sitcom link. (Lockheed Martin)

Tugs guide LCS-1 in Pearl Harbor in December of 2013. This design lacks a bow thruster, resulting in limited maneuverability in harbor environments. Changes to her topsides, compared to the picture at left show new radome configurations with smaller enclosures, offering less wind resistance and reducing weight. (Sean Furey / U.S. Navy)

LCS-2 *Independence*, at sea underway during the Rim of the Pacific (RIMPAC 2014) multi-national exercise. With all-aluminum construction, these ships cannot be painted. Mounted on the slender foredeck is a Mk 110 57mm cannon, with a mission module access hatch immediately aft of gun. Above the bridge windows is Bridgemaster-E navigation radar. Above the radar on a small platform at the forward edge of the deckhouse is a Seastar Safire III electro-optical/infra-red (EO/IR) turret. Flanking both sides of the deckhouse is a WSC-6 SHF satcom in gray radomes. The conical truncated radome atop the deckhouse houses a Sea Giraffe AMB/SPS-77(V)-1 3-D air/surface search radar. White radomes atop the tripod mast are for tactical control data-link antennas or TCDL. Just above these is the Link-16 AS-4127 joint tactical information distribution system or JTIDS antenna, with an ES-3610 ESM array above. Atop the mast is the URN-20 TACAN antenna. Surface warfare package Mk 46 30mm cannons are located just aft of the WSC-6 radomes. A SeaRAM 11-round missile launcher is at the aft end of the superstructure. (Carlos Gomez / U.S. Navy)

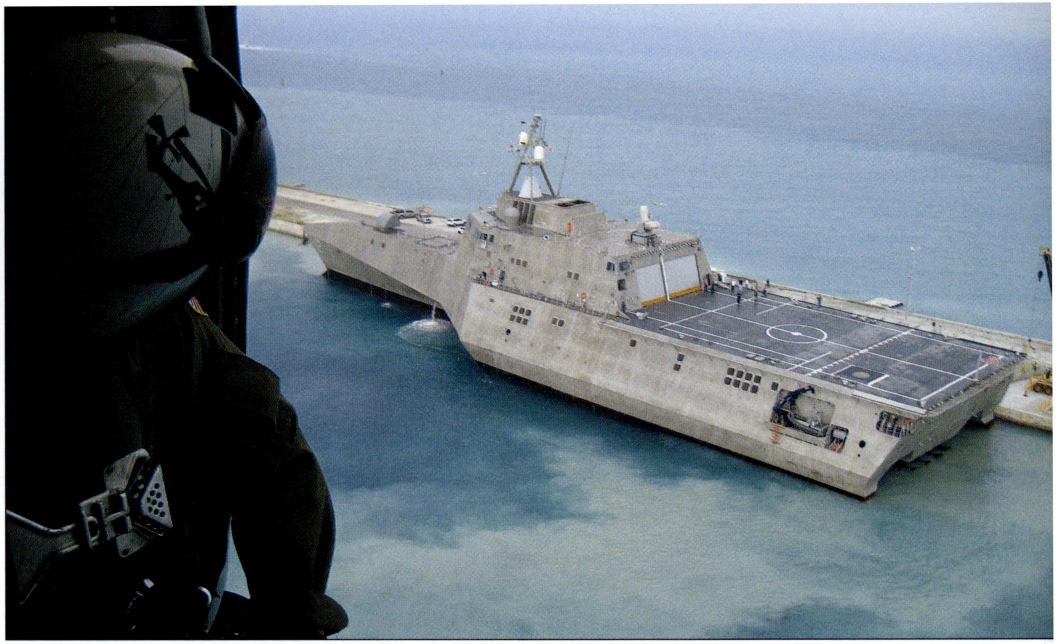
LCS-2 enters San Diego harbor as a security vessel races past to take up station alongside. *Independence* was returning from time spent in Florida, a transit of the Panama Canal, and a port visit to Mexico. A ceremonial lei hangs at her bow. The bow anchor is ready to use as a precaution. (Robert Winkler / U.S. Navy)

Pre-Commissioning Unit (PCU) LCS-4 *Coronado* arrives at her designated home port of San Diego, as her crew looks on from the pier. The crane will lift a gangway up to the side of the ship once she has docked. Beside her is T-AKR 30 *Bob Hope,* a large medium-speed roll-on sealift ship. (David Hooper / U.S. Navy)

With battle flag unfurled, LCS-2 cruises in the Pacific in April of 2014, at the conclusion of a photo exercise or PHOTOEX opportunity. These photo opportunities usually occur at the end of such events, with many ships gathered in a close formation, in order to photograph as many ships as possible. (Keith DeVinney / U.S. Navy)

LCS-2 meets up with the *Oliver Hazard Perry*-class frigate FFG-51 *Gary* off the coastline of Central America in January of 2015. LCS vessels will replace this class of ship, along with the *Cyclone*-class patrol craft and *Avenger*-class mine sweeper. (Taylor Petre / U.S. Navy)

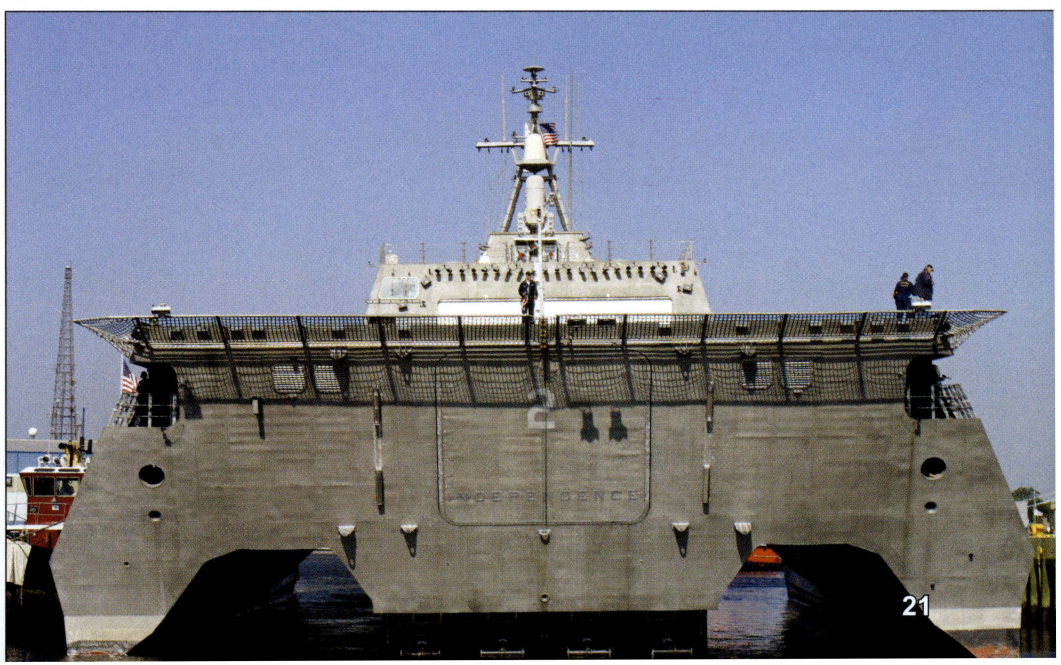
LCS-2 departs San Diego, California, for Pensacola, Florida, to test the mine counter measures package. Rub rails attached to the port outrigger prevent hull damage while the vessel is tied up alongside a concrete pier. The anchor is of the Danforth type, easy to extricate from the seabed. (Danny W. Ryan / U.S. Navy)



LCS-2 is docked at Mole Pier, Key West, Florida, in March of 2010. With a shallow draft and azimuth thruster, it has no problem docking at this or similar destinations. The four waterjet nozzles are just visible above the angled transom, designed to allow small boats and RMMV to be launched and recovered. (Nicholas Kontodiakos / U.S. Navy)

LCS-2 departs a foggy Mobile Bay for acceptance trials. In this starboard profile view, the aft side door gives access to the mission bay. The object on the rails in the recess aft of the door is a life-raft canister. The raft falls free of the ship and inflates if needed. An outrigger and two portholes in the bow are open. (Elizabeth Vlahos / U.S. Navy)

Flight deck safety nets are extended in this stern view of LCS-2 in port in Norfolk. The four waterjets and the two-section stern doors are visible. Both doors have four pins that fit into the brackets seen outboard of the door hinges. These pins hold the doors open. (Ed Ketz / BAE Systems)



The view from aft looking forward on the LCS-2 flight deck shows how big the area is with tie-downs recessed into the deck surface. Also visible are deck stripes, perimeter lighting, a radar control station location to the left and a helicopter hangar door. The smaller roll-up door to left is for VTUAV storage area. (Scott Reel / USMC)

Sonar Technician 2nd Class Dale Haynes and Information Systems Technician 3rd Class James Wanser haul mooring lines ashore as LCS-2 is guided to the pier at Mayport, Florida. Life jackets and protective footwear are always worn when a docking operation is underway. (Gary Granger Jr. / U.S. Navy)

LCS-2 passes under the Bridge of the Americas and enters the Pacific Ocean after a transit of the Panama Canal. The Jackstaff is erected and ahead of the 57mm gun because the foredeck is narrow and lacks side railings. Here the Kevlar shields are covered. (Trevor Welsh / U.S. Navy)

As LCS-2 departs Manzanillo, Mexico, in April of 2012, Chief Mineman Paul Bowling from Hyden, Kentucky, catches a heaving line thrown from the tugboat *Nevado De Colima* as she makes ready to gently nudge the ship out into the harbor. Tires on bow cushion the impact as the tug touches the hull. (Trevor Welsh / U.S. Navy)

LCS-2 in Pensacola, Florida, about to depart to conduct exercises in the Gulf of Mexico. These ships are of all-aluminum construction and have a sprint speed in excess of 40 knots. An anchor is located at the very end of the stem. Several round portholes along the hull sides are open. These are used for throwing and securing mooring lines as well as for observing ship clearances in canals and when docking. The deckhouse above the bridge windows has a truncated radome containing the Sea Giraffe AMB/SPS-77(V)-1 surface/air search radar. Flanking it are two gray WSC-6 SHF satcom radomes. At the top of the mast is the URN-20 TACAN with an ESM array for the ES-3610 suite, located below the two yardarms. Two white radomes located below array are for tactical control data-link (TCDL). This trimaran design is based on the Austal of Australia-designed Benchijigua Express ferry. LCS-2 has an overall length of 416.9 feet, an overall beam of 99.7 feet, and a draft of 14 feet. The ship weighs 3,000 tons at full-load displacement and its range at 18 knots is 4,300 nautical miles without refueling. (Caleb White / U.S. Navy)

LCS-1 conducts high-speed trials on Lake Michigan. The vessel is 387.6 feet long, with a beam of 57.7 feet. Its draft is 14.1 feet and its range at 14 knots is 3,500 nautical miles. The ship weighs 3,500 metric tons at full load. The 57mm Mk 100 gun is used on both classes of LCS ship types. (Lockheed Martin)

LCS-3 plows through heavy seas *en route* to the Foal Eagle 2015 exercise held off the Korean Peninsula. The LCS specification states that the ships must be able to transit quickly to conflict zones and begin operations once there. The hull design is based on the Italian Destriero commercial vessel. (Daniel M. Young / U.S. Navy)

LCS-3 *Fort Worth* races along at speed. A combination diesel and gas turbine (CODAG) arrangement of 2 Fairbanks Morse Colt-Pielstick 16 PA6B diesels rated at 8,700 brake horsepower each and two Rolls Royce MT-30 gas turbines rated at 98,000 shaft horsepower each drive four Kamewa waterjets. (Lockheed Martin)

LCS-1's helicopter landing pad is 5,200 sq. ft. with a 4,680 sq. ft. interior hangar space. Air operations can be conducted up to sea state 5. Rotary-winged aircraft such as MH-60 types, MQ-8B Fire Scout VTUAVs, to a single CH-53E heavy lift helicopter, can use the deck in a variety of operations. (Lockheed Martin)

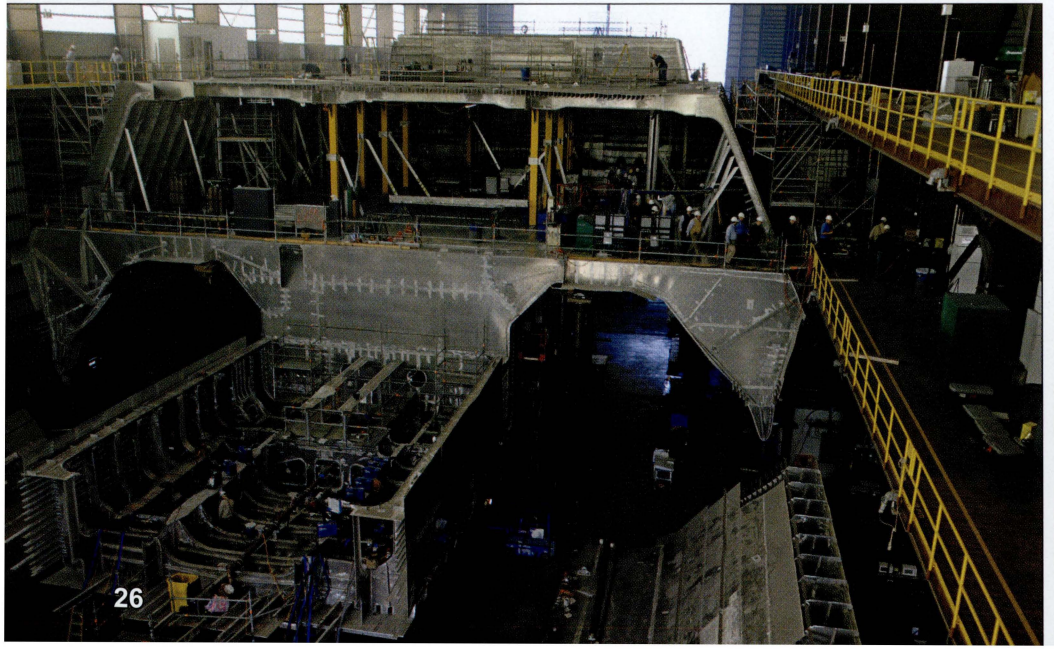
LCS-2 illustrates the fact that trimaran hull shapes generate limited wake. With less drag than other ship types, higher speeds can be achieved and maintained. Hull sides are sloped inward to reflect radar waves away from their source, an effort intended to provide a somewhat stealthy electronic signature. Square stack exhausts are aft of the mast. (Dennis Griggs / General Dynamics)

LCS-2 *Independence* sails a calm Gulf of Mexico during builder's sea trials in July of 2009. An abrupt change in course is indicated by the wake pattern behind the ship. Such maneuverability can be handy when having to avoid another vessel, moving in confined areas, or evading a torpedo. These ships also have an azimuth thruster, a useful tool when docking. (Dennis Griggs / General Dynamics)

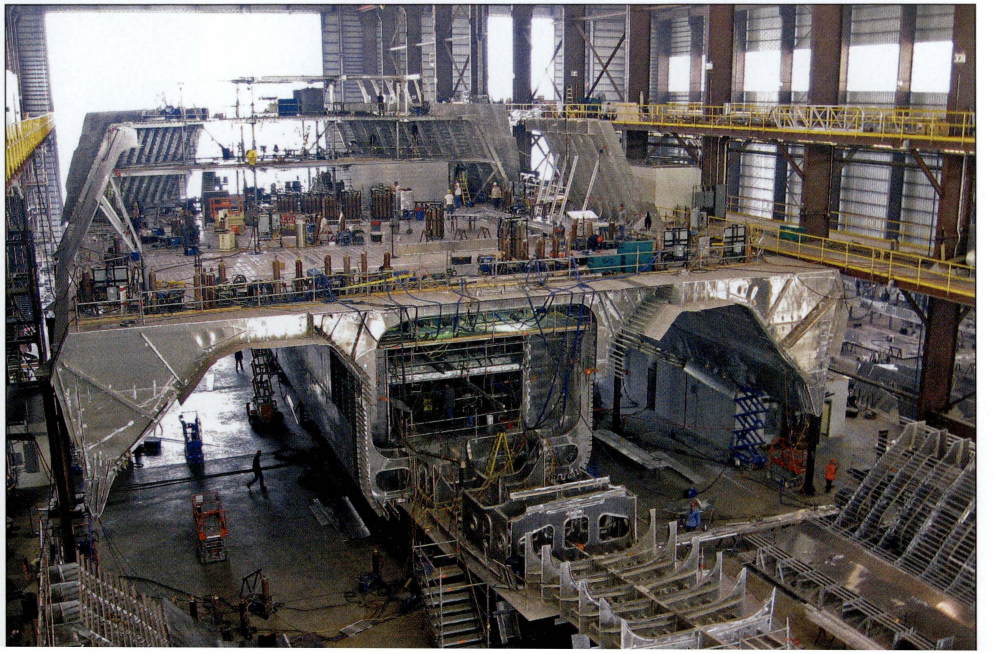
In July 2013, the Chief of Naval Operations (CNO) Admiral Greenert, tours the shipyard in Marinette, Wisconsin, where LCS-1 class ships are built, while contractor employees point out various assembly features of the ship. In this photo, a hull section is being examined and discussed. (Peter D. Lawler / U.S. Navy)

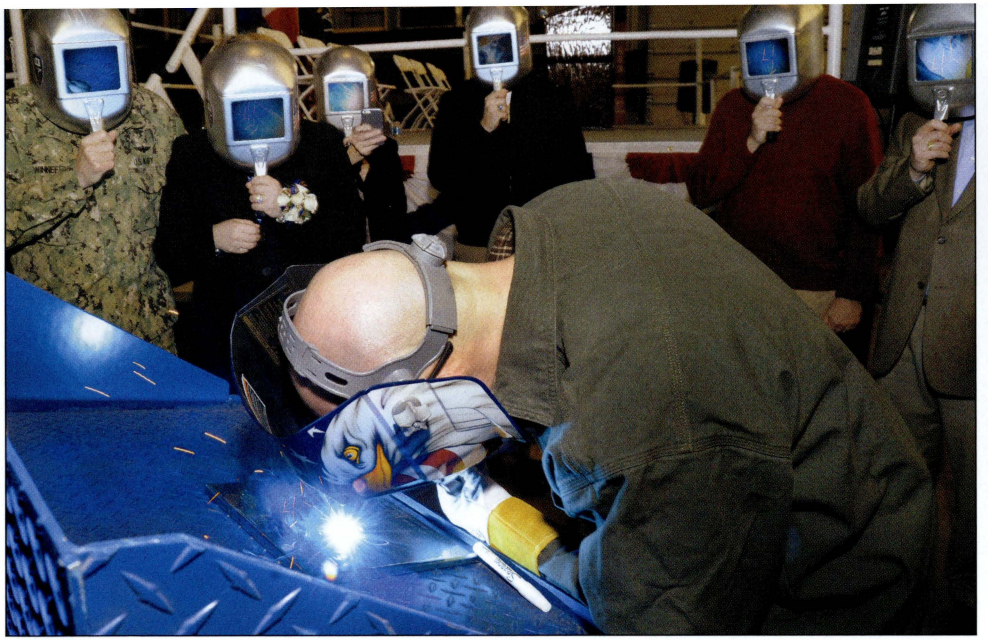
The Secretary of the Navy, Dr. Donald C. Winter, receives a briefing as construction continues on the LCS-2 ship *Independence* at Austal shipyard. Various hull shapes have been cut and welded, with some surfaces having been ground smooth. Such tours keep policy-makers informed as ships are built. (Shawn P. Ecklund / U.S. Navy)

Assembly of LCS-2 is well advanced in March 2007. The outrigger hulls, central hull and mission bay, supported by yellow jacks, are all identifiable. The central hull deck will accommodate engines, generators, reduction gears, and output shafts to the waterjets. (Shawn P. Ecklund / U.S. Navy)



LCS-2 is of a trimaran style hull design, with the central hull flanked by a pair of outrigger hulls. These designs allow for increased stability at sea, and provide a wide beam. Storage capacity is increased and a large flight deck offers many uses for helicopters of various sizes or deploying many UAVs. (Austal Ships)



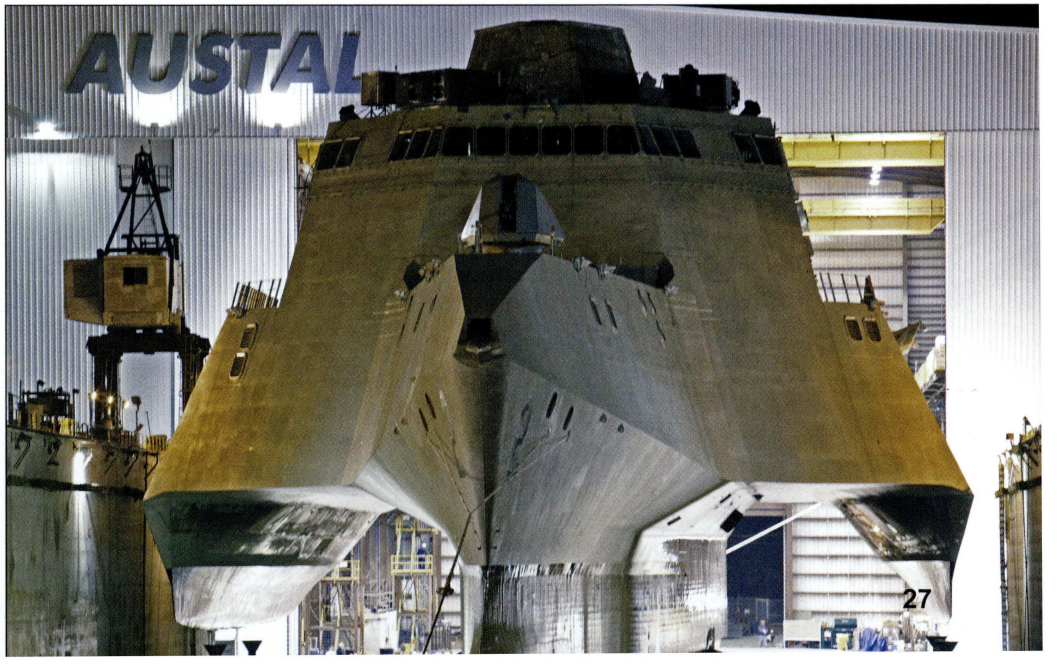


LCS-11 *Sioux City* ship's sponsor, Mrs. Mary Winnefeld, has her initials welded onto the keel block at Marinette, Wisconsin in February 2015. This is one of several traditional events for U.S. Navy warships. (Lockheed Martin)

LCS-1 *Freedom* is under construction. White tarpaulins cover sections where the waterjet ducts will eventually be installed. Cleanliness and safety are concerns for workers who are constantly moving to various levels to complete tasks and prepare for the next job. (Lockheed Martin)

Austal USA machine tool operators Wright and Sealy monitor the cutting of the first aluminum sheet for LCS-6 *Jackson*. Such precision, automated manufacturing tools are key elements in the advanced cutting, shaping, and design methods used in the creation of modern seagoing vessels. Data are entered into the tool interface, and the tool automatically cuts to prescribed specifications. (Austal USA / Dee Dee Bonner)

Outside the assembly building, LCS-2 *Independence* shows her hull form. Stabilizing fins attached to the main central hull add stability by preventing unnecessary rolling motions. The angled hull sides and gun turret mount are designed to reduce radar reflections. (Austal Ships)

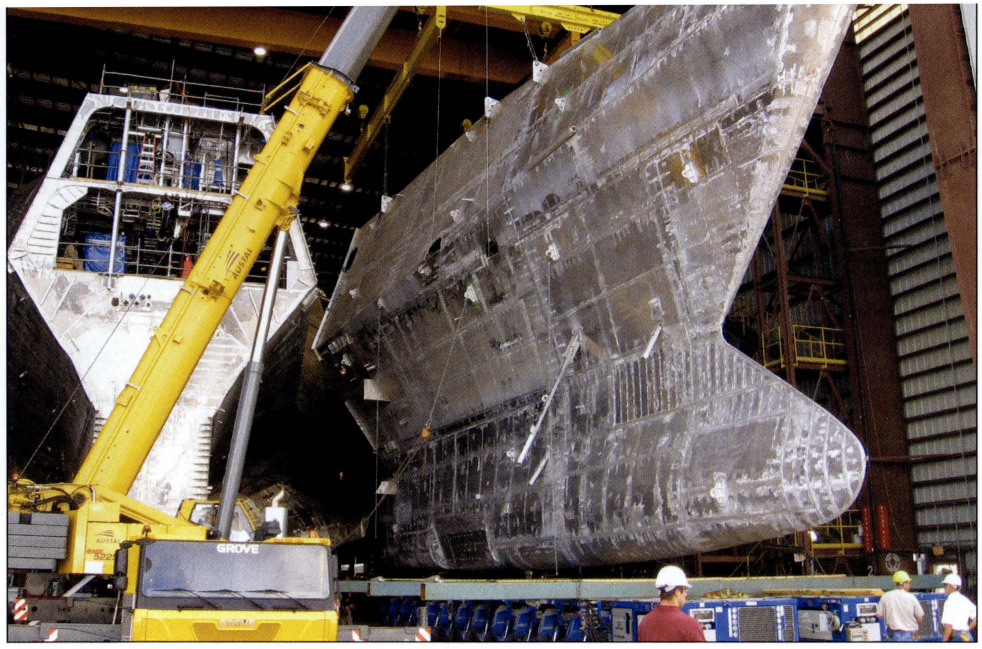


During a walking tour of the LCS manufacturing facility in Marinette, Wisconsin in July 2013, CNO Jonathan Greenert gets the latest update on construction progress. Forward sections of LCS-9 *Little Rock* await being joined together as part of the modular assembly technique. (Peter D. Lawlor / U.S. Navy)

Inspecting the assembly progress of LCS-4 in August 2011 is the CNO Gary Roughead, looking at sections of waterjet ducts that will be attached to the hull above. Waterjet propulsion is one of many innovations incorporated into the LCS class of warships. (Shannon Eve Renfroe / U.S. Navy)

In December 2013, PCU LCS-5 *Milwaukee* rests in a cradle before being launched sideways into the Marinette River. The amount of steel in her hull is 2,000 tons. The aluminum superstructure weighs 500 tons. Approximately 1 million feet of cable links all of her internal electronic systems together. (U.S. Navy)

On board LCS-3 *Fort Worth*, the pertinent documents transferring ownership of the vessel from the contractor to the Navy are reviewed by Commander Nathan Schneider, in Marinette Wisconsin, in June of 2012. This is but one of many milestones in the building of and delivery of naval vessels into the fleet. (U.S. Navy)



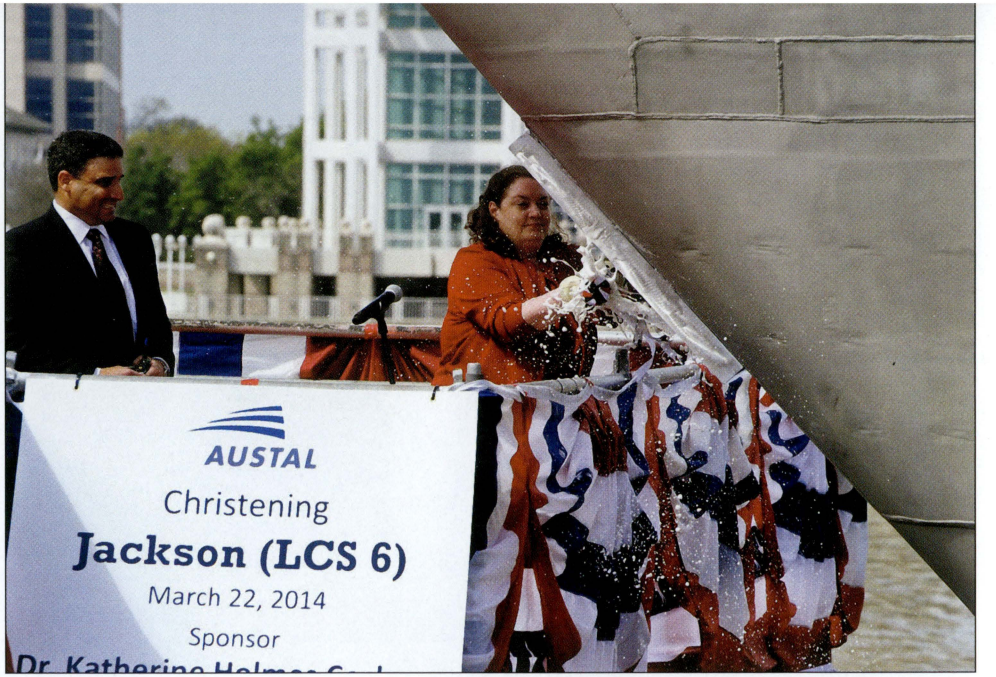
Cranes lift the completed bow section of LCS-4 *Coronado* into position to be moved into place and secured. The aluminum bow module lacks a sonar dome so instead of a bulbous shape, the forefoot is streamlined to minimize drag when underway. Aluminum surfaces will fade to a dull finish in time. (Austal Ships)

Before the Christening and launch of LCS-9 *Little Rock*, Secretary of the Navy Ray Mabus talks with news media about the significance of the event and the eventual addition of the 5th LCS *Freedom*-class ship into Navy service. Once in the water, the ship enters a fitting-out period before departure. (Sam Shavers / U.S. Navy)

The bow section of LCS-2 *Independence* shows a lack of stanchions and railings along the foredeck, open portholes alongside the hull, and unusual anchor stowage. The symbol beneath the number 2 is to alert crewmen and dock handlers of the delicate bulbous bow which extends forward under the waterline. (Doug Sayers / U.S. Navy)

In December of 2013, PCU LCS-5 *Milwaukee* slides sideways into the Marinette River. This method of launching is the only means possible due to the width of the river. Sideways launching keeps the vessel close to the riverbank, where it cannot drift far away once it leaves dry land. (Lockheed Martin)

LCS-1 ship's sponsor, Birgit Smith, performs the ritual of smashing a bottle of Champagne on the stem of the vessel being christened, in this case on 23 September 2006. (Lockheed Martin)



At the Austal USA shipyard on 22 March 2014, Dr. Katherine Holmes Cochran PhD, ship's sponsor for LCS-6 *Jackson*, christens the ship by breaking the bottle on a sharp metal bar tack-welded to the stem. (Austal USA / U.S. Navy)

The crew of LCS-1 *Freedom* man the rails after commissioning, on 8 November of 2008. Large radome is for WSC-6 SHF satcom link, above it is EO/IR turret. Shutters behind radome are air intakes for engines and generators. (Michael F. Miller / U.S. Navy)

The Secretary of the Navy, Ray Mabus, talks with Fire Controlman 1st Class Callow after the commissioning of LCS-6. It is up to the Secretary of the Navy to review and approve warship names. (Arif Patani / U.S. Navy)

LCS-3 underway in the Java Sea in January of 2014 in response to the loss of the Air Asia flight QZ8501. Water visible on her foredeck is a result of the location of the anchor hawsepipe on her starboard side being so low to the waterline, that when at high speeds in rough seas, the water enters and is forced upwards onto the deck. Searches such as this involve lookouts to spot any floating debris, along with using surface search radar to detect any objects. Use of sonar towed behind small craft can aid in finding wreckage that is on the seafloor. Once found, specialized ships can then assemble and begin recovering items such as flight recorders, engines, and other parts deemed important to attempt to solve how and why an aircraft was lost and to hopefully prevent such incidents from happening again. (Antonio P. Turretto Ramos / U.S. Navy)

LCS-1 passes *Capt. Henry Jackson* between locks in the Welland Canal after commissioning, on her way to Norfolk. Mooring lines are on deck ready to use and a tug assists with maneuvering at slow speeds. All LCS-class ships built at the yard in Wisconsin travel this route. (Kenneth R. Hendricks / U.S. Navy)

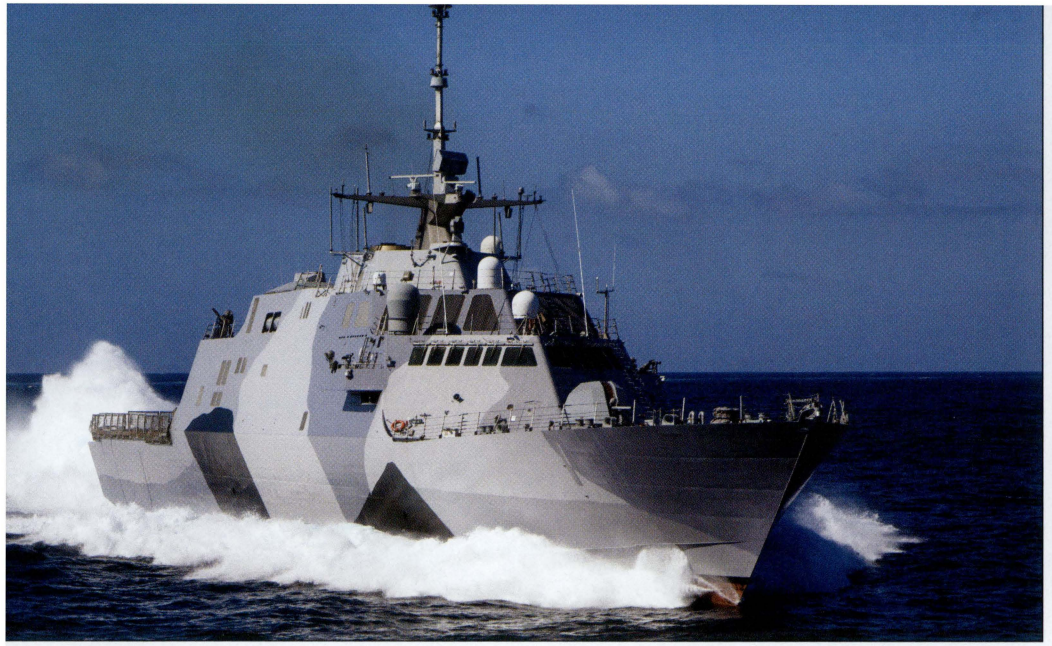
LCS-1 at Norfolk, Virginia, in May of 2009, with Jackstaff in the raised position. Low to the waterline is the anchor hawsepipe. The RMS autonomous vehicle and launches are displayed for visitors. Details of mast, radomes, radars, antennas, and deck gun are also visible. (Brien Aho / U.S. Navy)

The stern of LCS-1 is seen as she moves to the pier-side at Pearl Harbor. On both sides of the closed stern doors are trim tanks, added after the ship was built to provide more hull trim control when at sea. They do not interfere with high-speed cruising. (Tiarra Fulghum / U.S. Navy)

In the Pacific Ocean in May 2014, LCS-1 awaits the arrival of an MQ-8B Fire Scout, which is about to land. The ship is steaming into the wind on a straight course to ensure the helicopter landing goes smoothly. Fire Scout endurance is over five hours. One of its roles is to laser-designate targets to be attacked. (Tim D. Godbee / U.S. Navy)

LCS-1 *Freedom* is underway at speed, rooster tails evident. Such speeds can be of great advantage in reducing transit times, moving quickly from one zone of interest to another, chasing after vessels classified as hostile, responding to a call for assistance, or for evading a torpedo. A huge drawback is that replenishment of fuel becomes more urgent after several such speed runs. (Lockheed Martin)

Closed transom doors and raised flight-deck safety nets are visible at the stern of LCS-1. Aircraft control station windows are to left of the closed hangar door. Above the hangar door is the RAM missile launcher. Pilots use the white stripes on the deck as visual recognition aids for correctly approaching and landing. The landing area is illuminated with subdued lighting at night and in bad weather. (Lockheed Martin)



LCS-1 *Freedom* makes a high speed run with rooster tails evident. Sprint speeds such as this in a tactical situation would be useful for outrunning small boats or evading a torpedo. High-speed running reduces range dramatically. (Lockheed Martin)

This angle shows clearly exhaust stacks enclosed inside the superstructure, the mast with TACAN at the top, with AS-4127 JTIDS collar antenna below. Radars are on the platform ahead of mast. Radomes to left of the stacks and above air inlets are TCDL. The round gray radome is WSC-6. The white radome on same level as WSC-6 is a commercial satcom. (Lockheed Martin)

This bow view shows the uncluttered foredeck of the LCS *Freedom* class, as the anchor hauling mechanism is below decks. The jackstaff is folded. Stanchions along deck sides can be folded flat for gun firing or to use the forward deck as a vertical replenishment or VERTREP platform. The hull beam width aids in dispersing spray away from topsides. (Lockheed Martin)

As seen LCS-1 in an aerial view from the starboard aft quarter, a pair of trim tanks that were installed in December 2009 protrude from the transom. The tanks are used to level the hull or trim the horizontal angle to a level state. (Lockheed Martin)

LCS-1 in February 2013 makes a fast run while on builder's trials before being handed over to the Navy. The hull length increased once the pair of trim tanks, seen in this image, had been installed. A small bridge wing is the only obstruction on an otherwise clean hull side. The surface warfare mission package is installed, as evidenced by the twin 30mm guns. The Jackstaff here is folded. The vessel's unrefueled range at 14 knots is 3,500 nautical miles. (Lockheed Martin)

Wearing a camouflage paint scheme, LCS-1 has an MQ-8B Fire Scout VTUAV on the flight deck during an independent deployer certification exercise (IDCERTEX) in the Pacific prior to a deployment. The exercise is an opportunity to test the crew in a range of humanitarian aid, tactical, rescue, and surveillance scenarios. Along the aft hull is the side door access to the mission bay. Water venting from hull side is drawn into the ship and passed through heat exchangers, to cool onboard equipment. (Katarzyna Kobiljak / U.S. Navy)

LCS-1 *Freedom* is underway during builder's trials in February 2013. The ship has the surface warfare mission package installed. Visible are the dual Mk 46 30mm cannons atop deckhouse, with RAM launcher aft above the helicopter hangar door. The masthead has the URN-20 TACAN and JTIDS radome below. Aft of the mast are two large gas turbine exhausts. The ship is 387.6 feet long, with a beam of 57.7 feet, and a draft of 14.1 feet. Blackened areas on the hull sides obscure diesel engine exhaust outlets. Two aft extensions welded to the transom assist in trim stabilization to adjust the hull center of gravity. The vessel design is based on a semi-planing steel monohull. (James R. Evans / U.S. Navy)

PCU *Freedom* runs at high speed during tests. Speed has its advantages, but comes at the cost of increased wear on dynamic components, increased fuel consumption, and more down time for replenishment. Pouring it on while evading a torpedo or a small boat armed with missiles is never questioned! (Lockheed Martin)

LCS-1 refuels from LHD-6 *Bonhomme Richard*. The LHD class has virtually replaced the LHA class of amphibious assault ships, which were built in the 1970s and 80s. Both the LCS and LHD are similar in that they both use well decks for launching and recovering smaller vessels. (Marcus L. Stanley / U.S. Navy)

LCS-1 sails alongside LHD-6 *Bonhomme Richard* in the Pacific. In a tactical operation, the LCS would perform littoral duties to keep large ships such as this one safe as it operates in deep waters off-shore, deploying air cushion landing craft and aircraft to support a landing operation in denied territory. (Marcus L. Stanley / U.S. Navy)

An MH-60R gets ready to land on LCS-1. The ship must not move too fast while recovering an aircraft as the "burble" of air turbulence the ship creates as it moves could upset the approaching helicopter and cause it to miss a landing attempt or lose control and crash. (Aaron Burden / U.S. Navy)

This is the view from the bridge of LCS-3 as she keeps station in a formation of ships from Canada, Japan, and the U.S. Navy during a surface task group exercise. These close gatherings would never be part of a tactical scenario and are used to provide photo opportunities of many ships in a small area. (Tim D. Godbee / U.S. Navy)

While at sea in February of 2010, LCS-1 takes on fuel from T-AO 195 *Leroy Grumman*. Electronic Technician 1st Class Daniel Store signals the guide ship to proceed as the hose connection is made. LCS crewmen are trained to do multiple tasks as a result of the reduced crew complement. (A.C. Rainey / U.S. Navy)

LCS-1 Commander Jim Edwards looks forward as his ship awaits the refueling hose being hauled across a cable to start an at-sea refueling operation with the *Wasp*-class ship LHD-6 *Bonhomme Richard*. Were it not for underway refueling, many warships could not venture out into open ocean. (Lt. Ed Early / U.S. Navy)

LCS-1 takes on fuel from atomic-powered aircraft carrier CVN-70 *Carl Vinson*. *Vinson* is 1,098 feet in overall length, weighs 101,264 tons at full load, has a flight deck beam of 252 feet, and a draft of 37 feet. Two pressurized water A4W reactors can move the ship to speeds over 30 knots via 4 steam turbines. (Ashley Van Dien / U.S. Navy)

Underway in the Pacific Ocean in April of 2010, LCS-1 *Freedom* refuels from the *Nimitz* class nuclear powered aircraft carrier CVN-70 *Carl Vinson* during carrier strike group or CSG operations. Once the hose has been passed across and the probe end inserted into the drogue receptacle on the receiving vessel, fuel will be pumped into tanks until the required amount is achieved. Both ships maintain a speed of about 13 knots and a constant heading, while keeping a 200-foot distance. If agreed upon by both vessels, a connected course change or "Corpen November" maneuver can be performed. The vessel receiving fuel is designated as the customer. The ship offloading fuel is labeled as the guide. The initial fuel flow rate is 40 pounds per square inch (PSI) while being checked for leaks. If none is found, pressure is increased to 100 PSI for the duration of the refueling operation. At 100 PSI, the flow rate is around 3,000 gallons per minute or GPM. Distillate fuel marine or DFM is used for ship propulsion. If aviation fuel is needed for embarked helicopters or UAVs, JP-5 is pumped instead. If vertical replenishment or VERTREP is needed for palletized cargo, this may be done as refueling continues. LCS class ships do not have the ability to do a connected-stores replenishment, as they lack the necessary equipment for such operations. In addition to using an aircraft carrier for replenishment, dedicated resupply ships such as the *Henry J. Kaiser*-class oilers and *Supply*-class combat support ships assigned to both Atlantic and Pacific fleets perform this kind of work exclusively. In order to conduct effective blue-water naval operations on a large scale, a navy must have a well trained, reliable and dependable resupply network in place in the form of purpose-built ships and shore installations. (Ashley Van Dien / U.S. Navy)

In the Java Sea, MDSU-1 Navy diver Clarke is about to deploy the Tow Fish side-scan sonar from an 11-meter RHIB during the January 2015 search for the missing AirAsia plane. As the device is pulled along behind the boat, it transmits signals that create images of objects lying on the seafloor. (Antonio P. Turretto Ramos / U.S. Navy)

In the Atlantic, LCS-3 takes a heavy wave over her bow in August 2012 as water runs down the bridge window. Starboard lines are on deck ready to use when the ship docks. Mounts and shields for three .50-caliber machine guns are visible, two to starboard and one to port. (Josue L. Escobosa / U.S. Navy)

A caving ladder is lowered over the side of LCS-3 during a vessel boarding search and seizure (VBSS) operation. Teams work together in all aspects of every phase of these drills, swapping positions so they are familiar in what to do in case another member is delayed or incapacitated. (Conor Minto / U.S. Navy)

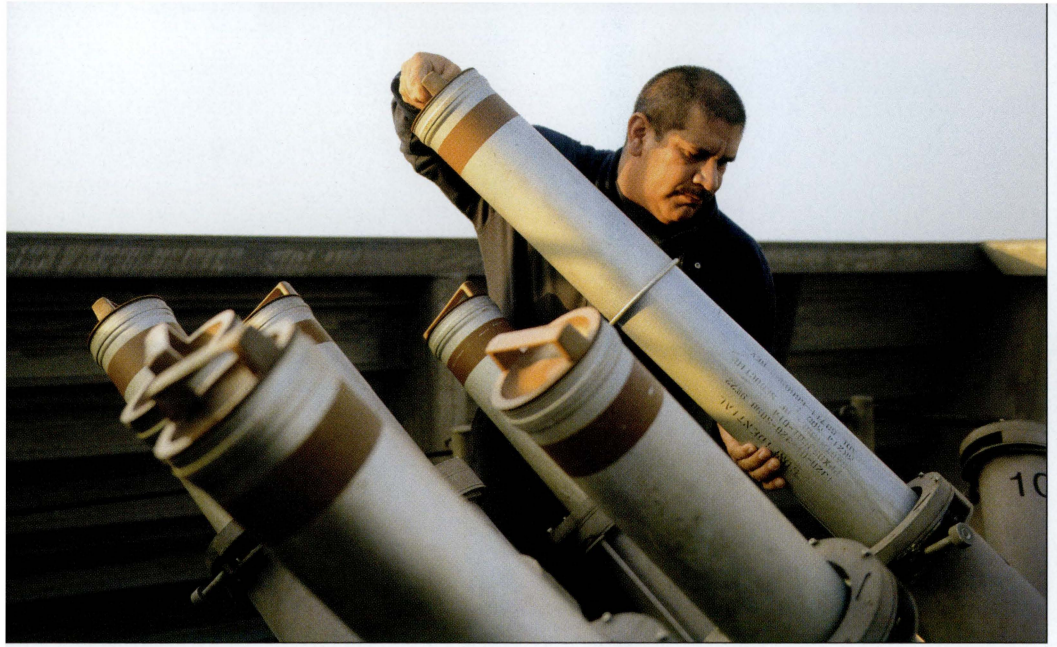
Guiding a phone and distance line between CVN-70 *Carl Vinson* and LCS-1 *Freedom* in April 2010 is Petty Officer 2nd Class Chris Payton as the two ships make ready to conduct a refueling in the Pacific Ocean. Contact and distance is established first before refueling begins. (Michael Barton / U.S. Navy)

Passing the jetty is LCS-3 on its way to its first port call on the island of Guam in the Pacific Ocean in December 2014. The hangar door is open and safety nets around the flight deck are raised. Port calls are appreciated by the crew for time ashore to visit new lands but also to support various humanitarian projects. (Leah Eclavea / U.S. Navy)

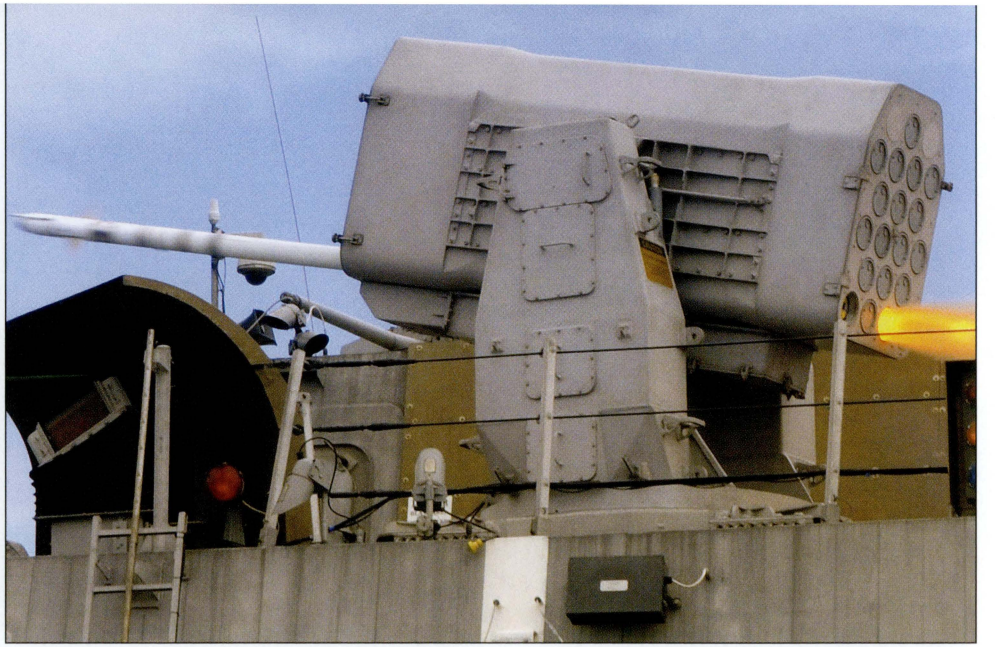
LCS-3 sails the South China Sea in transit to deployment in the Pacific Ocean. The flight deck safety nets are extended. The aft WSC-6 radome is covered in soot from the stack exhausts. The deckhouse area between the RAM launcher and the Mk 46 30mm guns is for a future AGM-114 Hellfire VLS cell installation. (Joe Bishop / U.S. Navy)

As seen by a hovering helicopter, LCS-1 cruises quietly off the California coastline. Aft trim tanks are fitted, the RAM launcher is elevated. The surface warfare mission module package is installed, as indicated by the two Mk 46 30mm guns atop the aft deckhouse. Air intake grills can be seen along the hull sides. (James R. Evans / U.S. Navy)

At the conclusion of the exercise Malabar 2015 drill, a photo op is taken to record the vessels that participated in the event. This shot is of LCS-3 as she keeps her station with a Seahawk helicopter on the flight deck. Splinter camouflage hides two diesel exhausts along the hull sides. (Chris Brown / U.S. Navy)



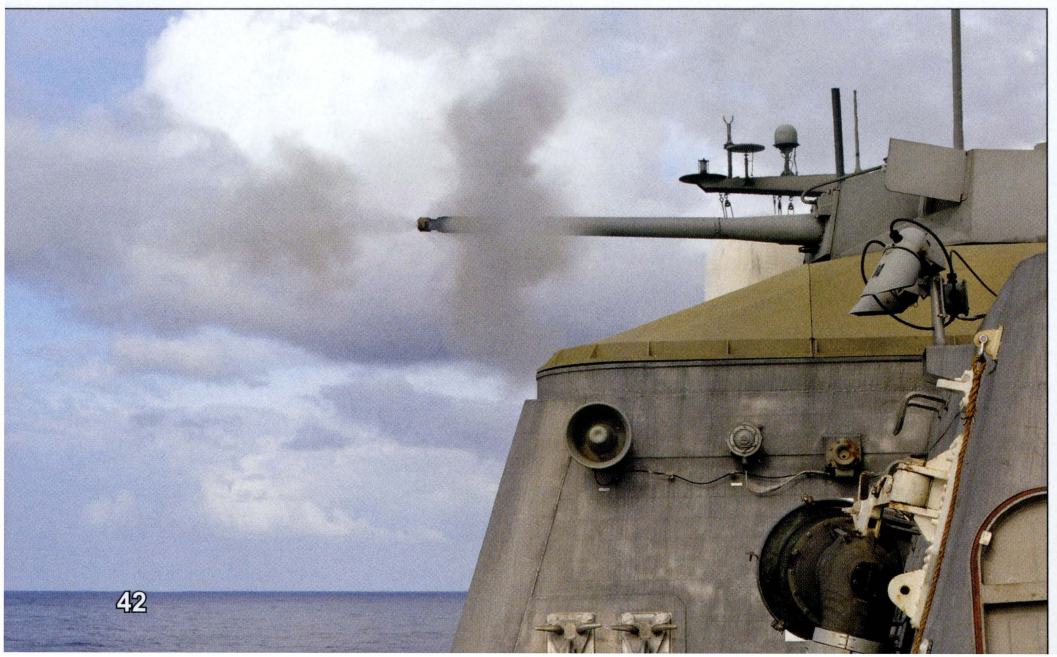
Fire Controlman Pina unloads a Mk 214 Mod 1 chaff cartridge from the Mk 137 launcher on LCS-1 before entering port. Chaff rounds release large clouds of foil strips, in order to confuse and cause an inbound anti-ship missile to break lock and miss the ship while the ship evades the threat. (Cassandra Thompson / U.S. Navy)



A RIM-116 rolling airframe missile (RAM) is fired from LCS-1 during the RIMPAC 2010 multi-national exercise. Mk-49 missile launcher holds 21 rounds and weighs 10,949 pounds above deck, 1,760 pounds below deck. The missile speed exceeds Mach 2 and its range is 6 nautical miles. (Lt. Ed Early / U.S. Navy)

LCS-1 fires its port Mk 46 30mm cannon off the coast of Hawaii during the RIMPAC 2010 exercise. Each gun contains 400 rounds in the turret and a ready service magazine has another 240 rounds. The entire Mk 46 package can be stored and shipped in three cargo containers. (Lt. Ed Early / U.S. Navy)

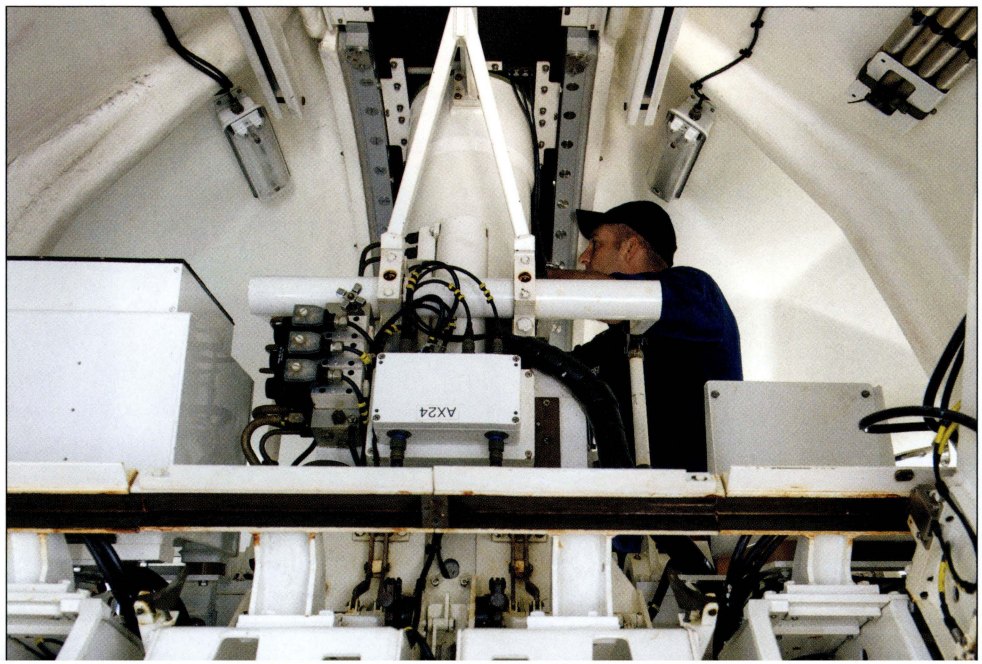
A RAM launch in June 2009 is seen from the flight-deck of LCS-1. The missile length is 9.1 feet, its weight is 161.7 pounds. The weapon is effective against small boats, cruise missiles, UAVs, and aircraft. The first U.S. Navy ship to have RAM installed was LHA-5 *Peleliu* in 1992. (Lockheed Martin)



LCS-1 takes on a pallet of 57mm ammunition to be loaded into the below-decks magazine through the open hatch. The operation is underway at Seal Beach, California, prior to a major Pacific Fleet ordnance drill. Rounds will be sorted and armed, then loaded into the gun for firing. (Jeff Steele / U.S. Navy)

During a surface gunnery test, BAE Systems Mk 110 57mm gun fires aboard LCS-1. The turret shape reduces radar reflections. The ammunition capacity in the gun is 120 rounds. The gun's rate of fire is 220 rounds per minute and its maximum range is 10.5 miles. A velocimeter above the barrel tracks round trajectory. (Lt. Ed Early / U.S. Navy)

In port in San Diego, prior to the vessel's departure for a live-fire exercise, Gunner's Mate 1st Class Bieber checks the internal mechanisms of the 57mm gun, No manual operations are involved inside the turret: everything has been designed to function automatically. The gun is aimed below-decks. (Karolina A. Oseguera / U.S. Navy)



Hot brass ejects from LCS-1's 57mm gun as it fires at targets during a live-fire drill. The deck stanchions and jackstaff are lowered to eliminate obstructions while the gun is in use. The rubber mats under the barrel prevent spent brass from damaging the deck. The turret shape is of a low radar-cross section design. (Cassandra Thompson / U.S. Navy)

Gunner's Mate 2nd Class Andrew Thomasy and Fire Controlman 1st Class Waylon Clement load 30mm high-explosive incendiary (HEI) rounds into one of the Mk 46 guns on LCS-3. All electrical and hydraulic power is isolated from the gun while the loading operation takes place. (Antonio P. Turretto Ramos / U.S. Navy)

On LCS-3, 57mm rounds are arranged on deck. Rounds have plastic bands around the base to reduce barrel wear. Firing pins no longer ignite the powder; it is now ignited by an electrical contact. A yellow band is used to indicate that the round is live. (Antonio P. Turretto Ramos / U.S. Navy)

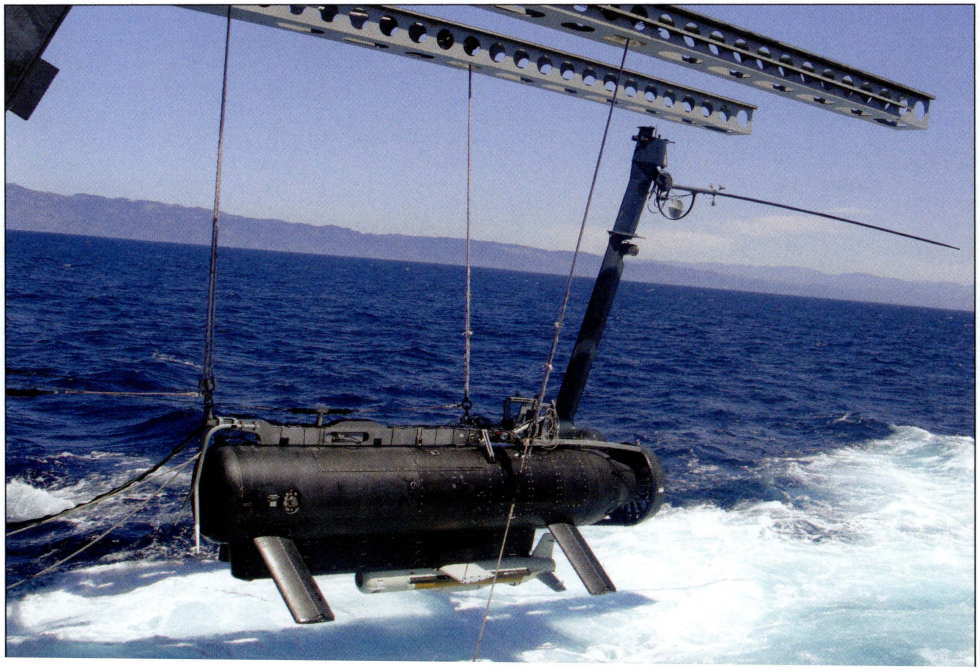
After a VBSS drill using actual weapons, the LCS-4 crew takes time to strip down and clean them. The M-4 rifles seen here have adjustable stocks and Picatinny Rails around the barrel that allow mounting tactical lights, lasers, or hand grips. Laser sights can also be mounted on a rail over the barrel. (Debra Daco / U.S. Navy)

While cruising in the Gulf of Mexico, .50-caliber machine gun drills are carried out on LCS-4 in January of 2014. Crewmembers have to load, aim, and fire the weapon, then clean it after the live-fire is completed. Kevlar armor shields are in place to protect against any ricochets. (Andrew Johnson / U.S. Navy)

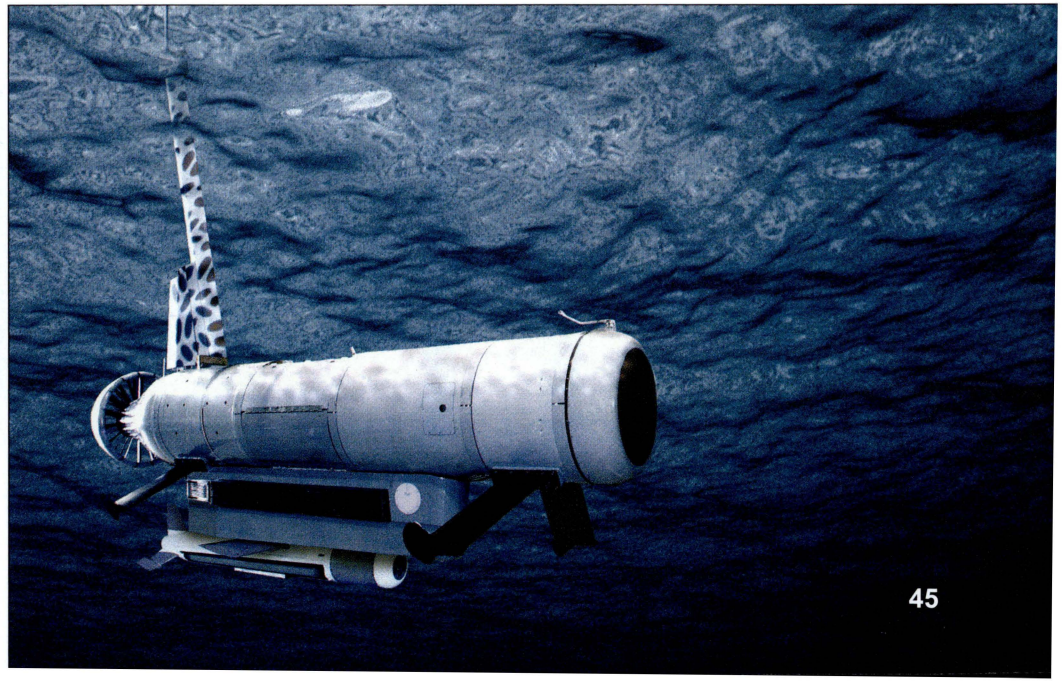
A major component of the mine-hunting mission package is this remote multi-mission vehicle or RMMV, seen here being brought back aboard LCS-2. Attached to the bottom is the AQS-20A advanced mine hunting sonar system that is streamed behind the RMMV as it searches for mines. (Ron Newsome / U.S. Navy)

WLD-1(V)-1 Unit 21 undergoes maintenance checks in Fort Lauderdale, Florida, prior to being taken out to sea for trials. The remote mine-hunting vehicle weighs 12,850 pounds, has an overall length of 23 feet, and a fuel capacity of 289 gallons. The Cummins 370B engine runs on JP-5 or marine diesel fuel. (David Sussman / U.S. Navy)

The RMMV, like this on LCS-2, can be programmed to search autonomously or be controlled by a remote station. The RMMV weighs 12,850 pounds and is 23 feet long. Its engine is a Cummins 370B diesel with a fuel capacity (diesel/JP-5 or marine) of 289 gallons. The mast has a video camera and air intake for the engine. (U.S. Navy)



In this illustration an AQS-20A sonar unit is docked beneath a WLD-1(V)-1 remote mine-hunting system (RMS) deployed under water. The WLD-1(V)-1 can be programmed to search in various patterns while towing the AQS-20A sonar unit behind it. (U.S. Navy via Lockheed Martin)

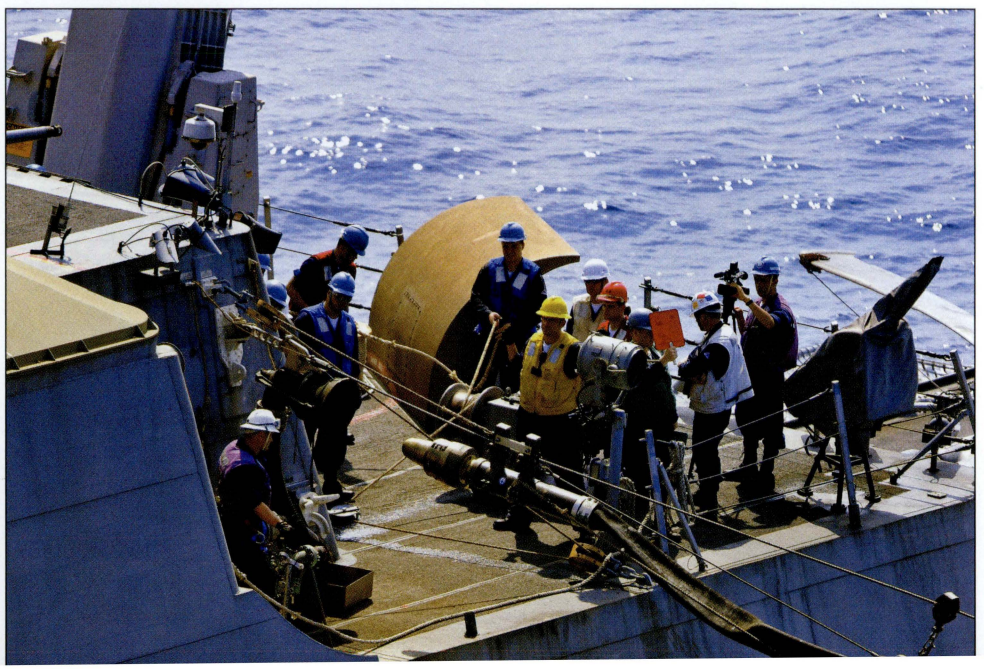


In the Atlantic, *en route* from Norfolk, Virginia to Mayport, Florida, in November of 2009, LCS-1 *Freedom's* bridge crew monitors activities and systems. Large windows provide excellent visibility with reduced reflections due to the windows' inward slant. (Rafael Martie / U.S. Navy)

On her first daytime connected underway replenishment or UNREP operation in July of 2010, during the RIMPAC 2010 exercise, LCS-1 *Freedom* takes on mail and cargo from T-AO 200 USNS *Guadalupe*. A refueling hose is connected into the drogue just behind the crewmembers. (Lt. Ed Early / U.S. Navy)

In October of 2013, the engineering department on LCS-1 conducts a test of the onboard diesel generators by placing an electrical load on them. Such systems are highly automated, and will provide the operators with diagnostic data and alert them to problems while the equipment is in operation. (Karolina A. Oseguera / U.S. Navy)

A view of LCS-1 *Freedom* as seen from CVN-70 *Carl Vinson*, as she passes a refueling hose via a cable to begin refilling fuel tanks. Deck crew all have specific tasks, denoted by the color of their vests. The purple color is associated with the fuel department. (Lt. Ed Early / U.S. Navy)



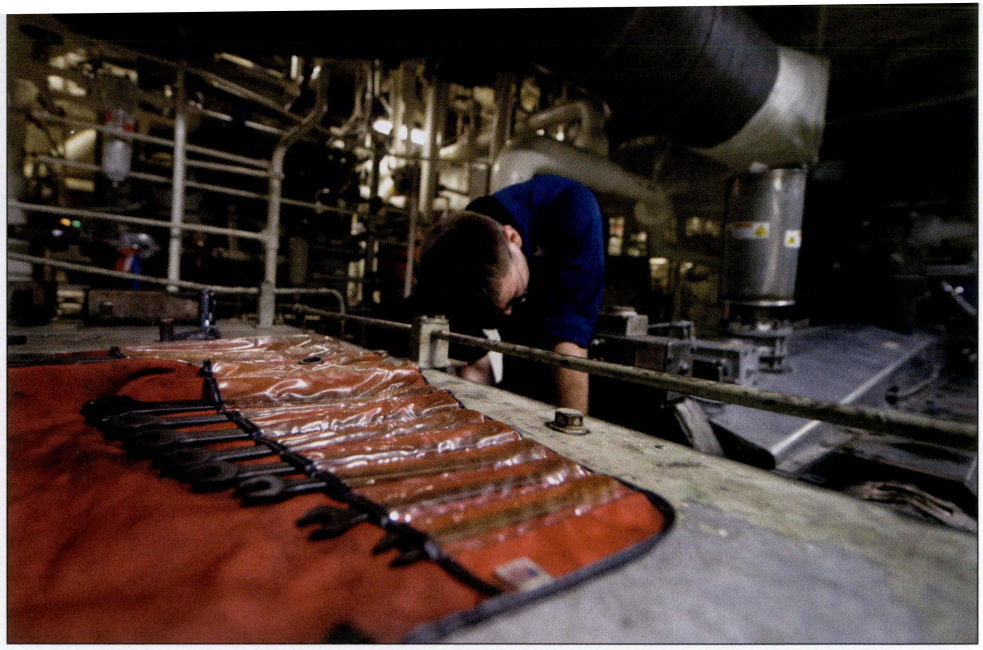
During a rescue drill in February 2010, an MH-60S aircrewman, fitted out to look as if he had been burned in a fire, is removed from the aircraft by the first responders on board LCS-1. Rescuers wear turnout gear and hoods as well as self-contained breathing apparatus (SCBA) air packs. (Lt. Ed Early / U.S. Navy)

At Norfolk in May 2009, LCS-1 deck crew haul in mooring lines in readiness to get underway. The deck is coated with a non-skid compound, so personnel cannot slip on a wet deck surface. Working as a team insures smooth line retrieval. Once aboard, the line is coiled on deck or stored until needed again. (Jhi L. Scott / U.S. Navy)

Mineman 1st Class Jeffrey Steele and a crewman bring aboard a bale of Cocaine seized from a drug smugglers' boat. Looking on is the LCS-1 commanding officer, Randy Garner. The operation netted a 1-ton haul of the illicit drug, proving that LCS ships can be effective at drug interdiction missions. (Lt. Ed Early / U.S. Navy)

A Thanksgiving feast is prepared in the galley of LCS-1 by Mineman 1st Class Avelar and Senior Chief Operations Specialist Dunning while LCS-1 is in Quebec City, Quebec in November 2008. The Navy makes sure that crews at sea are well fed and that there is a wide variety of menus each week. (Kenneth R. Hendricks / U.S. Navy)

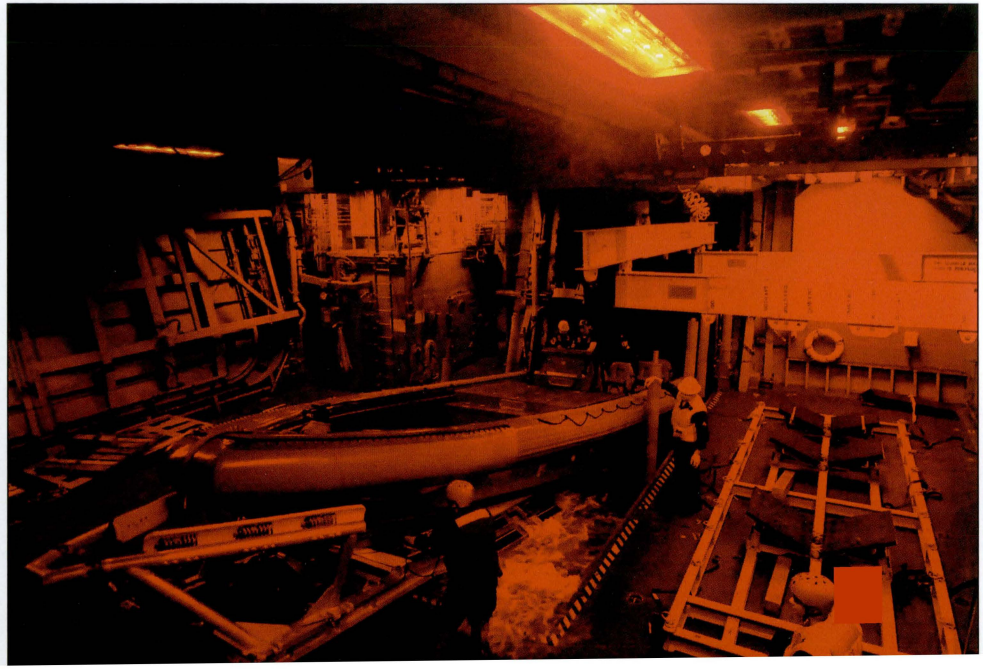
In January of 2008, Admiral Gary Roughead, Chief of Naval Operations, tours the bridge of LCS-1 while visiting Marinette, Wisconsin, where this type of ship is built. Visible are the display screens, throttles, and various dials, switches, and knobs, making this one of the most automated ships ever designed. (Tiffini M. Jones / U.S. Navy)



While in port in Singapore, Engineman 1st Class Robert Carter performs routine maintenance on one of LCS-1s diesel engines in July of 2013. Two of these engines provide slow speed propulsion power and are rated at 8,700 brake horsepower (bhp) each. (Karolina A. Oseguera / U.S. Navy)

Senior Sailor of the year Fire Controlman 1st Class Clifford Smith is at his post, monitoring displays and interacting with a trackball and keyboard in the mission control center or MCC. Tours of duty typically last for eight hours. His headset is plugged into an intercom system capable of contacting any department. (Jhi L. Scott / U.S. Navy)

A night launch of the rigid-hull inflatable boat or RHIB in the mission bay of LCS-1, is bathed in red light. This counter illicit trafficking (CIT) operation, is a patrol mission in the Caribbean Sea undertaken in February 2010. Anti-drug smuggling enforcement efforts are carried out 24 hours a day. (A.C. Rainey / U.S. Navy)



LCS-1 is in San Diego during a four-month maintenance period after sea trials in July 2011 to make repairs while still under contractor ownership. This ship and LCS-2 are known as Flight 0 ships, and have served as testbeds for both designs. Modifications have been adopted on future ships. (Elena Pence / U.S. Navy)

LCS-2 *Independence* zig-zags during trials off of San Diego in July of 2013. Waterjet propulsion makes turns easy, and more responsive as, unlike a rudder, the entire waterjet assembly moves as a unit. The slender central hull and outrigger hulls offer little water resistance. (Daniel M. Young / U.S. Navy)

LCS-3 makes a turn off the coast of Hawaii, during deck landing qualifications by Army UH-60 Blackhawk helicopters. LCS-3 and later ships of this type have a hull of 12 feet increased length, and a 12% increase in fuel capacity. These ships are known as Flight 0+ variants. (Antonio P. Turretto Ramos / U.S. Navy)

LCS-2 shows the ability to spin in its own length by use of an azimuth thruster. The device is retractable and is valuable for precise maneuvering and docking. The wake of the thruster can be seen under the trimaran hulls. Use of thrusters is now standard for many ships as well as pleasure craft. (Daniel M. Young / U.S. Navy)

LCS-2 in RIMPAC 2014, as she steams with the other ships that took part in the annual exercise. These Rim of the Pacific drills allow naval forces of Pacific region nations to work together in simulated phases such as amphibious assaults, defending against aircraft and missile attacks, live-fire actions that sink real ships that have been decommissioned, anti-submarine warfare as well as submarine penetration of surface action groups' inner perimeters. At the end of these exercises, before the participants disperse for their home ports, a photo exercise or PHOTOEX gathering is arranged so that ships can form into a massive group for formation drills and the chance for photographers to record images of all of the naval forces that took part in the event. LCS *Independence*-class shape, tripod mast, hull design, trimaran shape, long, slender foredeck and anchor arrangement are all seen here. (Shannon Renfroe / U.S. Navy)

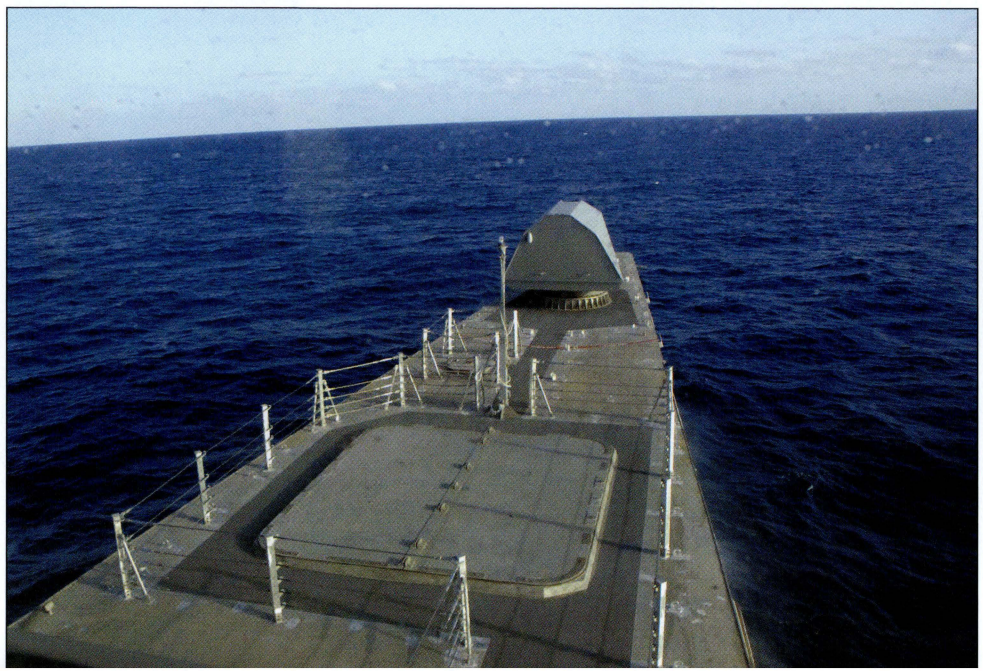
Looking out of place amongst cruise ships, LCS-2 rests in Key West in March of 2010. A red floating barrier keeps the curious at bay and will contain any residual fuel or hydraulic fluid, should any be accidentally released. Void spaces between hulls reduces air friction at speed, another aerodynamic plus. (Lt. Zachary Harrell / U.S. Navy)

LCS-2 is tied up at Mole Pier, Key West, in March of 2010 before heading up north to Norfolk. The large flight deck area is also a design feature incorporated into FSF-1 *Sea Fighter* that is described earlier and of HSV-2 *Swift* (ex-Incat 061), both single ship examples intended for uses other than that of the LCS class. (Nicholas Kontodiakos / U.S. Navy)

Its stern doors closed, LCS-2 *Independence* conducts sea trials in July of 2009. An RHIB with davit is at the aft end of the port outrigger. A SeaRAM is above the hangar deck doors. A tripod mast surrounds the radome housing the Sea Giraffe 3-D radar. The trimaran design allows for a large, internal volume. (Dennis Griggs / General Dynamics)

LCS-2 moves at speed. Sprint speed is around 40 knots. Four Wartsila waterjets are driven by a dual pair of two LM-2500 gas turbines and two MTU 20V8000 diesels, in a combination diesel and gas turbine arrangement or CODAG. The transit range is 3,500 nautical miles. (General Dynamics / U.S. Navy)

The long, slender bow of LCS-2 is seen from the bridge. Aft of the 57mm gun is a space for mission package loading into the bow section. In some future arrangement, this space could house a vertical launch missile or VLS cell. The stem anchor and hardware are mounted internally, leaving a clear fore-deck area. (Lt. Zachary Harrell / U.S. Navy)



The LCS-2 flight-deck is the largest for a surface combatant, excluding LHA/LHD- and CVN-class ships. To reduce radar reflectivity, the vessel's sides are angled to bounce radar waves away from the emitter. Exhaust stacks are within the deckhouse, aft of the mast. (Dennis Griggs / General Dynamics)

Constructed entirely of aluminum, LCS-2 *Independence* is conducting builder's trials in the Gulf of Mexico. Gray radomes located along either side of upper deckhouse are for WSC-6 super-high frequency (SHF) satellite communications. The tripod mast has at its very top a URN-20 TACAN antenna, with the ES-3610 ESM array below. (NAVSEA / General Dynamics)

Underway, the reveals her long foredeck and minimal wake due to the trimaran hull shapes. With its flight deck is 38 feet above the waterline, sea spray interference with aviation operations is greatly reduced. The truncated radome shape surrounded by a tripod mast contains the Sea Giraffe AMB/SPS-77 surface search/air search radar. (NAVSEA / General Dynamics)

During builder's trials before acceptance by the Navy, LCS-2 is underway in the Gulf of Mexico in July of 2009. The water discharges are from air conditioning systems and heat exchangers that cycle cool water into interior machinery to take away built up heat and then pump it overboard. (Dennis Griggs / General Dynamics)

LCS-2 and LCS-4 sail in formation for a photo opportunity in the Pacific in April 2014. Even though they are sister ships of the same class, differences can be seen in the lack of bridge wings on LCS-4, and in the design changes in the stem anchor housings on both ships. (Keith DeVinney / U.S. Navy)

Tugboats gently nudge LCS-2 into her designated docking section at Pearl Harbor after participating in RIMPAC 2014. The ship also has an azimuth thruster, to offer some maneuvering in close-quarters situations like these. Streaks along hull sides are due to water discharges staining the aluminum plating. (Tiarra Fulghum / U.S. Navy)

As a phase of the annual RIMPAC exercise, ship formation drills are performed as LCS-2 moves to the port side of the *Nimitz*-class nuclear-powered aircraft carrier CVN-76 *Ronald Reagan.* LCS-2's stern doors are open. A few crewmembers on the helicopter landing deck show just how large the area is. (Dustin Kelling / U.S. Navy)

LCS-2 exits Gatun Lock on the Panama Canal during the first transit by the ship to its home port of San Diego. From this bridge view it appears that the ship has plenty of space in which to maneuver, but amidships clearance is measured in inches as the outriggers and wide beam make for a tight fit. (Trevor Welsh / U.S. Navy)

LCS-2's integrated command center (ICC) is located in a section adjacent to the bridge consoles. Taking advantage of the open architecture concept allows for upgrades to all systems, unhindered by proprietary obstacles. Displays can be viewed by all, improving situational awareness. (General Dynamics / Austal USA)

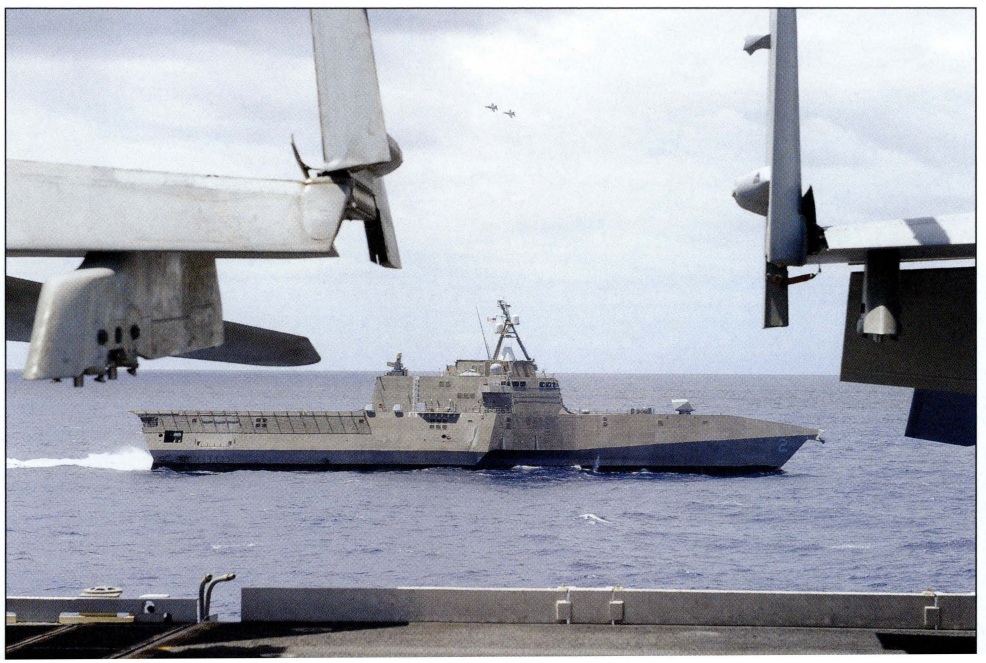
This bridge scene on LCS-2 shows how highly automated functions have become. The joystick can be used to order turns, increased or decreased speed, and call up other functions such as screen menus, through which adjustments can be made to radio frequencies, and to view navigation charts. (General Dynamics / Austal USA)

Operations Specialist 1st Class Ryan Saylor mans the tactical action coordinator station on LCS-4 while at sea in May of 2013. This position allows for a look at many inputs from sensors, other ship's intelligence, on-shore analysis and crew findings during a simulated or actual combat drill. (General Dynamics / Austal USA)

As an E/A-18G Growler is flung from the deck of CVN-76 *Ronald Reagan,* LCS-2 fulfills a role as plane guard while flight ops proceed. The plane guard duty is to respond swiftly to an aircraft ditching at sea, moving in to rescue the aircrew should a problem occur during takeoff. (Conor Minto / U.S. Navy)

An MH-60S Seahawk helicopter gets some attention on LCS-1 as the ship cruises in the Caribbean Sea. These helicopters have a long proven record in Navy use, beginning with the SH-60B, SH-60F, and HH-60H. Current versions include this example and the MH-60R. (Lt. Ed Early / U.S. Navy)

Framed between the folded wings of F/A-18 Hornets, and with a pair of them flying overhead, LCS-2 steams alongside CVN-76 *Ronald Reagan* during the RIMPAC 2014 exercise. Attending the event were more than 200 aircraft, 49 ships, six submarines and more than 25,000 personnel from 22 nations. (Chelsea Kennedy / U.S. Navy)



Before the day's flying begins, the flight-deck gets a thorough examination for any foreign objects that can enter engine intakes or cause damage by striking rotor blades. The "FOD walk" insures the deck is clear and ready for action. An MQ-8B is secured to the deck of LCS-3 in the background. (Katarzyna Kobiljak / U.S. Navy)

An LCS-3 MQ-8B Fire Scout is secured on deck before a flight in the Celebes Sea in December 2014. The sensor turret at the helicopter's chin has wide and narrow angle daytime optics, a laser, and infra-red imaging. The round antenna at the top of the nose is one of two data-link antennas. (Antonio P. Turretto Ramos / U.S. Navy)

In the Java Sea in January 2015, an MH-60R of HSM-35 "Magicians" gets ready to land on the deck of LCS-3 *Fort Worth*. The Seahawk was airborne, searching for debris from the AirAsia QZ 8501 airliner crash. LCS-3 skipped a scheduled maintenance call to help out in the search effort. (Antonio P. Turretto Ramos / U.S. Navy)

While LCS-3 is in port in the Republic of Korea, RoK midshipmen get a briefing on the capabilities of the MQ-8B Fire Scout assigned to HSM-35. The tour is part of exercise Foal Eagle 2015 and such visits benefit both nations as they learn the capabilities each other can offer in joint exercises. (Abraham Essenmacher / U.S. Navy)

An MH-60S Seahawk, bureau number 167818 of HSC-22 "Sea Knights" hoists an aircrewman from the deck of LCS-1 while in the hover. The helicopter has external stores support system (ESSS) wings installed so extra fuel tanks or weapons can be hung. (Lt. Ed Early / U.S. Navy)

As an MQ-8B hovers nearby, a pair of RHIBs approaches a cargo ship about to be boarded during a vessel boarding search/seizure or VBSS drill. The Fire Scout helicopter streams images back to LCS-1 in real-time, extending the sensor range of the ship and contributing to a safe and successful operation. (Tim D. Godbee / U.S. Navy)

An MQ-8B Fire Scout prepares for a mission on the flight deck of LCS-3 during night operations in the South China Sea. The VTUAV sensor turret has infra-red optics enabling clear images to be sent via the TCDL data-link to the ship for further scrutiny, analysis or action if required. (Conor Minto / U.S. Navy)

While LCS-3 *Fort Worth* maintains a steady course, an MQ-8B Fire Scout of HSM-35 Det 2 approaches to land on the flight-deck. The VTUAV can land autonomously, or be manually flown in for a landing. Safety nets are extended as a precaution whenever aircraft operations take place. (Conor Minto / U.S. Navy)

On display in the port of Changi, in Singapore, is an MH-60R Seahawk and a MQ-8B Fire Scout. The helicopters are on the deck of LCS-3 *Fort Worth* which will soon host visitors welcomed aboard for a tour. The ship can operate 2 MH-60s or a single helicopter and several VTUAVs. Air ops can continue up to Sea State 5. (Conor Minto / U.S. Navy)

One component of the mine warfare package is this AN/AES-1 airborne laser mine detection system pod or ALMDS, used to find mines from the air. As the helicopter flies over suspected minefields, the laser penetrates the water to detect them. A modified strut holds the 805-pound device. (Dave Sussman / U.S. Navy)

LCS-3 *Fort Worth* is framed in the open starboard door of an MH-60 of HSM-35 while in flight over the South China Sea. Naval doctrine today utilizes helicopters attached to ships in many roles, from disaster relief, to anti-ship surveillance targeting (ASST) missions, to mine and submarine hunting. (Conor Minto / U.S. Navy)

In the port of Sembawang in Singapore, Aviation Electrician's Mate Etoryia Anderson and Dakota Flint of HSM-35 Det 3 inspect the main rotor head of an MH-60R Seahawk in the hangar deck of LCS-3 in September 2015. Major inspections involve disassembly of systems such as removing rotor blades seen here. (Joe Bishop / U.S. Navy)

Flight-decks can be used by other military services. This Army UH-60 of the 25th Combat Aviation Brigade is conducting qualification drills on LCS-3 off the coast of Hawaii. Inter-service operability is crucial when joint maneuvers are planned and executed. (Antonio P. Turretto Ramos / U.S. Navy)

An MH-60S Seahawk helicopter of HSC-6 makes a slow approach in the hover, as a cargo pendant is held by a crewmember of LCS-2. The pendant will be attached to the cargo hook and, once secure, the aircraft will ascend with its payload and deliver it to another ship. (Charles White / U.S. Navy)

Boatswain's Mate Seaman Brian Hurley to left, and Boatswain's Mate 2nd Class James Fitzpatrick move a pallet of cargo with a floor jack to the hangar of LCS-3. Both men wear cranial headgear and hearing protection, as well as eye protection. Netting keeps cargo in place while being transported. (Joe Bishop / U.S. Navy)

A vertical replenishment (VERTREP) takes place during an exercise in cooperation afloat readiness and training or CARAT Bangladesh 2015. The helicopter is an MH-60R. A cargo hook is visible in the square recess in the chopper's belly. An aircraft crew chief is visible above the starboard main landing gear tire. (Joe Bishop / U.S. Navy)

A detail watches as an MH-60R brings another load of cargo from T-AO 199 USNS *Tlippecanoe,* seen keeping station in the background as both ships cruise in the Sulu Sea in August of 2015. The radar visible above the crewmen is used for precision controlled helicopter approaches to the flight deck. (Joe Bishop / U.S. Navy)

An MH-60R helicopter of HSM-73 is loaded with relief supplies on board LCS-1 while stationed in Leyte Gulf in the aftermath of Hurricane Haiyan which caused damage in the Philippines. Humanitarian assistance is an ongoing role that Naval vessels regularly perform. (Karolina A. Oseguera / U.S. Navy)

While cruising in the Celebes Sea, LCS-3 is resupplied by a helicopter from T-AO 204 USNS *Rappahannock*. Vertical replenishment or VERTREP is regularly done between ships at sea as a quick method of distributing cargo. The LCS-class ships lack the gear to accomplish a connected resupply. (Antonio P. Turretto Ramos / U.S. Navy)

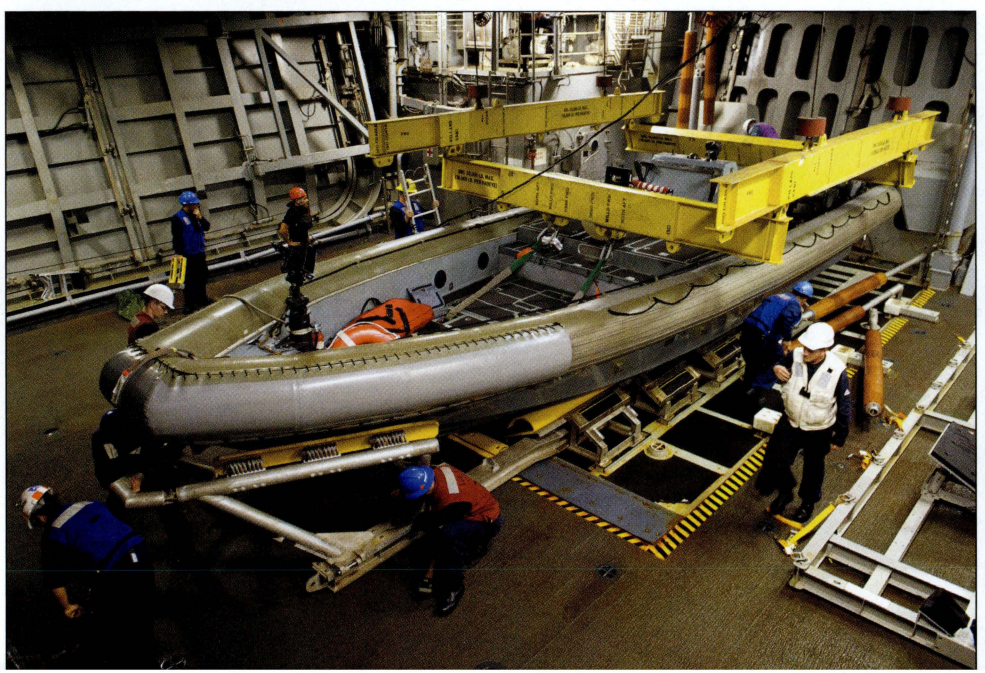
A wide variety of helicopters other than dedicated Navy types can also use the flight decks of warships. Here an AH-1W Super Cobra, of Marine Air Group (MAG) -24 lands on LCS-3, guided by Boatswain's Mate 2nd Class Adam Garnett. The AH-1 series dates back to the Vietnam Conflict. (Antonio P. Turretto Ramos / U.S. Navy)

As LCS-4 and T-AO 187 *Henry J. Kaiser* close the distance for a refueling operation, Culinary Specialist Casey Clayburg uses a laser to obtain a reading in order to establish the proper separation between the ships. Maintaining the same speed and course insure a safe rendezvous. (Debra Daco / U.S. Navy)

Off the coast of California in May of 2014, LCS-1 awaits the docking of a rigid-hull inflatable boat (RHIB) after VBSS training. This version of LCS is best suited for the use of small vessels, the LCS-2 type is better suited to the employment of aviation assets. (Tim D. Godbee / U.S. Navy)

Marines of Bravo Company, 1st Recon Battalion conduct launch and recovery drills off the California coastline. LCS-1 is found to offer more flexibility when launching far off-shore, proving that these ships are suited for work as part of a Special Operations mission. (Christopher J. Moore / U.S. Navy)

In the mission bay of LCS-1, the crew rushes to launch the RHIB in response to a man-overboard drill in the Straits of Singapore. To left is the port-side bay access door for side launching or recovery of small boats. Crews work fast but also simultaneously follow safety practices. (Karolina A. Oseguera / U.S. Navy)



An RHIB is launched from LCS-2 during RIMPAC 2014. Two overhead rails have to be extended aft past the transom, over the open water, for small boats or unmanned vehicles to be launched or recovered. A commercial navigation radar is mounted under the arch above the RHIB crew. (Corey T. Jones / U.S. Navy)

A "go-fast" drug smuggler's boat is detained and inspected by an LCS-1 RHIB with a Navy and Coast Guard crew aboard, in the Eastern Pacific in March of 2010. The search yielded bales of cocaine and the smugglers arrested. Use of an LCS allows for other ships to be used elsewhere. (Lt. Ed Early / U.S. Navy)

During RIMPAC 2014, LCS-2 is used as a vessel being boarded, as a Republic of Korea (RoK) VBSS team ascends a caving ladder up the hull side. Once the team is aboard, a search begins for hostages, hostile crewmen, or for suspicious cargo. A supporting ship is nearby if assistance is needed. (Corey T. Jones / U.S. Navy)

An RHIB assigned to LCS-1 looks for and recovers bales of cocaine, thrown overboard by smugglers while trying to evade capture. Two tons of the drug were seized, as were the smugglers and their boat. High seas drug enforcement is an ongoing Navy and Coast Guard effort. (Lt. Ed Early / U.S. Navy)

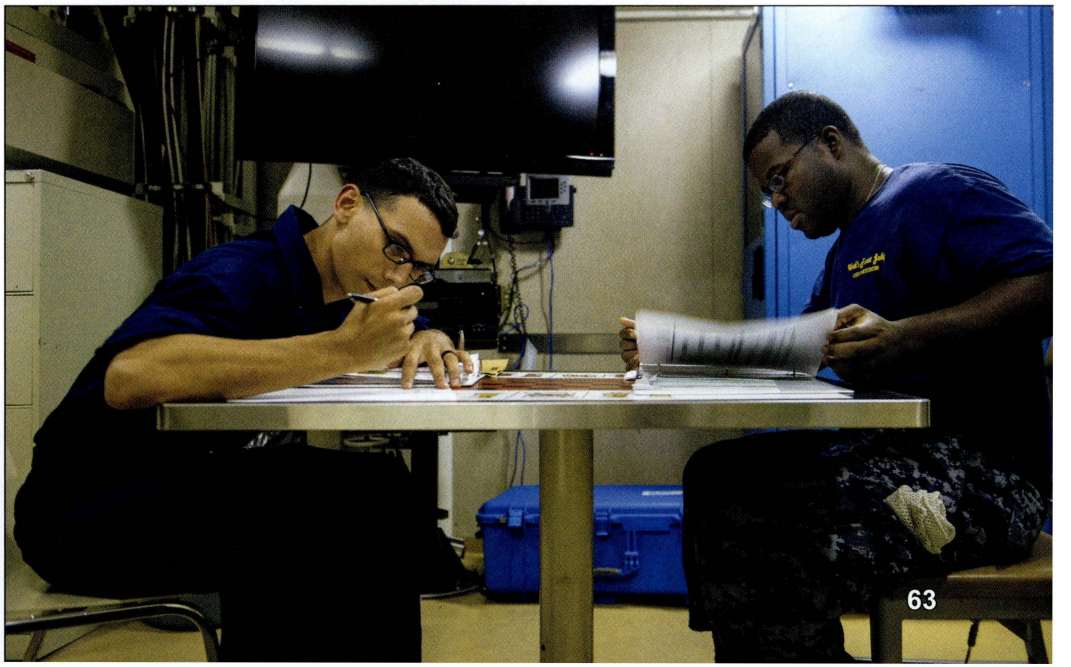
While the other VBSS members climb the ladder, Gunner's Mate 1st Class Thomas Culbertson holds the caving ladder steady as his LCS-1 crew train on their own vessel. Techniques are constantly practiced and refined to insure an actual operation goes quickly and safely. (Karolina A. Oseguera / U.S. Navy)

Pearl Harbor, Hawaii – Cmdr. Roger D. Heinken is piped through the sideboys during a change of command ceremony for LCS-1. He relieves Cmdr. Patrick Thien as the commanding officer (CO). Such ceremonies have been a part of the U.S. Navy way of life for hundreds of years. (Amanda Dunford / U.S. Navy)

LCS-1 crew member Jedediah Lamping demonstrates the "Sprawl Out" defensive tactic in October 2014 while the LCS-1 crew is on shore liberty in Singapore. Such physical activity and techniques are a daily routine for those who engage in diving, VBSS work and in the Special Forces. (Karolina A. Osequera / U.S. Navy)

In January of 2014, while in San Diego, Ensign Dolph Eich is awarded his surface warfare officer pin during a ceremony on LCS-1. Officers advance by constantly learning new skills and applying them, with support from fellow officers and from enlisted crewmembers. (Donnie W. Ryan / U.S. Navy)

Operations Specialist Seaman Anthony Villa and Culinary Specialist Seaman Marc Andre study for the enlisted surface warfare specialist rating on LCS-1 in August of 2013. Passing academic tests and hands-on exercises are a sure way to make rank and advance in today's United States Navy. (Karolina A. Oseguera / U.S. Navy)



Off the Florida coast, the crew of LCS-1 releases a "killer tomato" which is an inflatable target to be fired upon during small-arms familiarization drills. All hands must demonstrate proficiency in loading, firing, and cleaning small arms such as handguns, rifles and machine guns. (Lt. Ed Early / U.S. Navy)

Divers Clarke and Soulliard of Mobile Diving and Salvage Unit 1 aboard LCS-3 check a Tow Fish side-scan sonar prior to its use in the hunt for the lost AirAsia flight QZ 8501. Towed along by a small boat, the device scans the seabed, producing high-quality maps. (Jay Pugh / U.S. Navy)

Gas Turbine Systems Technician Tim Mastbergen descends a ladder into one of the LM-2500 exhaust stacks for a scheduled inspection on LCS-3. One disadvantage of using gas turbines is the need for large uptakes and exhaust ducts, which take up space and add weight. (Conor Minto / U.S. Navy)

Using the cross-chest carry as a means to get his victim to safety Gunner's Mate 1st Class Culbertson, a search and rescue (SAR) swimmer, makes his way back to the LCS-3. Divers also recover torpedoes and launch and recover submersible craft. (Conor Minto / U.S. Navy)

On the port bridge wing, Lt. Cmdr. Antonio Hyde uses binoculars to watch an underway replenishment (UNREP) between LHD-6 *Bonhomme Richard* and LCS-1 in August of 2010. To his left is LCS-1 CO Patrick Thien. To his left is Cmdr. Jim Edwards. (Lt. Ed Early / U.S. Navy)

After docking in Singapore, Engineman 3rd Class Javier Giron, who is attached to the surface warfare mission package on board LCS-1, takes a shore power cable to be plugged into a receptacle to provide electricity while in port. Doing so allows the on-board generators to be shut down. (Cassandra Thompson / U.S. Navy)

LCS-1 commanding officer Patrick Thien, holds the flag indicating the source of a simulated fire on an area of the flight-deck. All hands on every Navy ship are taught firefighting skills and can swiftly assemble, don protective gear and extinguish fires before they get out of control. (Karolina A. Oseguera / U.S. Navy)

A work detail on LCS-2 sweeps up in the mission bay, an evidently large section of the ship. With such available space, multiple small boats, remote underwater vehicles, and mission package containers can be stored and used simultaneously. Overhead rails are stored in this view. (U.S. Navy)

The CO of LCS-2, Cmdr. Joseph Gagliano, explains mission bay operations with Rear Admiral Stuart Mayer, commander of the Australian Fleet. Ships from many nations were gathered in Pearl Harbor for the annual RIMPAC 2014 exercise. While in port, crews take the chance to visit each other's vessels. (Chantell Bianchi / U.S. Navy)

A VBSS team from the Indonesian vessel 358 *Kri John Lie* storm the bridge of LCS-2 during a training drill conducted as a part of Cooperation Afloat Readiness and Training or CARAT 2015. Such events allow other nations to board, search, and perform tasks on vessels other than their own. (Joe Bishop / U.S. Navy)

Cmdr. Matthew Kawas, of LCS-3 crew 103, conducts an interview for local news media on board the ship while on a port visit to Đà Nẵng, in the Socialist Republic of Vietnam, during a scheduled naval activity in Vietnam event. Such visits by naval vessels promote stability and generate co-operation. (Conor Minto / U.S. Navy)

Indian Navy officers Rear Admiral Singh and Commodore Bhatnagar are given a tour of LCS-2 by the CO, Joseph Gagliano. Naval officers regularly visit each other's ships to compare notes and have time to discuss common naval matters. Crew member exchange visits are also a part of the routine. (Corey T. Jones / U.S. Navy)

As a search and rescue (SAR) exercise occurs, LCS-1 Fire Controlman 1st Class Gary Dagdagan monitors the event. This drill is one part of the Singapore Navy's Western Pacific Multi-Lateral Sea Exercise or WMSX. Nations have exercises on a frequent basis to hone skills with allied countries. (Cassandra Thompson / U.S. Navy)

While in the port of Sasebo, Japan, in March of 2015, Gunner's Mate 2nd Class Cassell maintains one of the Mk 46 30mm guns on LCS-3. Various cables, wire bundles, and trays, hydraulic lines, and motors must be visually scanned and if found to be out of specification, repaired or replaced. (Conor Minto / U.S. Navy)

Another day in the South China Sea begins with the maintenance crew of HSM-35 getting an MQ-8B Fire Scout VTUAV ready for a day of flight. Blades are unfolded and secured, brackets are removed, fluid levels and fuel are checked, diagnostic sensor tests are undertaken, and tie-down chains are released. (Conor Minto / U.S. Navy)

After delivery to LCS-1, containers of 57mm shells are loaded into a storage magazine. They will be inventoried and stowed away until needed. For a live-fire drill, the rounds will be loaded into a device that feeds rounds above-decks into the unmanned gun turret. (Jeff Steele / U.S. Navy)

On its first port call, LCS-2 is shown to Mexican dignitaries while visiting the city of Manzanillo in April of 2012. The bridge, with displays illuminated and controls described, captures the attention of the assembled guests and showcases U.S. Navy technology as well as a gesture of support to allies. (Trevor Welsh / U.S. Navy)

The Blue Angels aerial demonstration team flies over LCS-4 while it conducts tests of on-board equipment in the Gulf of Mexico in August 2013. The planes, F/A-18 Hornets, thrill audiences at airshows every year. The team is also a recruiting tool used to sign up volunteers for Naval service. (Rachel McMarr / U.S. Navy)

Chief of Naval Operations, Admiral Jonathan Greenert, poses with a pilot and civilian contractor employee by an MH-60S Seahawk on LCS-2 that has the pylon and pod for the AQS-235 airborne mine neutralization system. This equipment is part of the mine-hunting mission warfare package LCS ships will deploy. (Nathan Laird / U.S. Navy)

A visit to LCS-1 by Admiral Kevin Quinn, Commander Naval Surface Force Atlantic, allows him to see features of the ship such as the Mk 110 57mm gun, being shown to him by Gunner's Mate Matthew Carlisle on an informal walk-around of the vessel. Carlisle points out the velocimeter device. (A. C. Rainey / U.S. Navy)

In waters off the Korean Peninsula, LCS-3 Fire Controlman Joshua Hart of surface warfare mission package detachment 1, descends a caving ladder to an RHIB in order to conduct a VBSS drill. RHIB deck has many access panels for storage and for maintenance access. (Conor Minto / U.S. Navy)

The Gold Crew of LCS-2 gather for a group portrait in Mobile, Alabama. They will relieve the Blue Crew in a concept of crew utilization familiar from submarine operations. An LCS seaframe has a complement of 40. This number will increase when a mission module package is installed. (Lt. Cmdr. T. Chinyavong / U.S. Navy)

As seen from the RHIB vantage point, Boatswain's Mate 1st Class Tyler Horn guides the small boat into the well deck of LCS-3. He must proceed slowly, but fast enough to slide the bow into the cradle. At that point lines are made fast. The boat is then secured and lashed down to be moved. (Antonio P. Turretto Ramos / U.S. Navy)

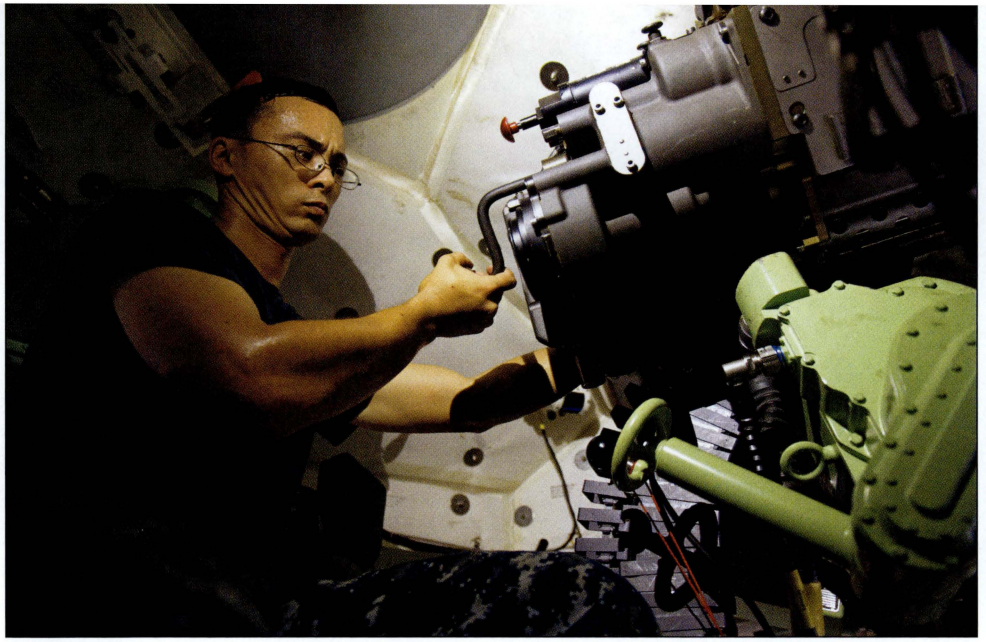
After a week of drills and training at sea, an aluminum beach picnic is the order of the day on LCS-4. Breaks such as these allow the crew to relax and unwind, catch up on mail, news, and rest. Others will follow up on outstanding maintenance and training documentation. (Debra Daco / U.S. Navy)

On the foredeck of LCS-3, Culinary Specialist 1st Class Robert Parks, from Fostoria, Ohio, hauls in a mooring line in readiness to depart from Singapore. As with many shipboard tasks, a team works together as behind Parks are others that are heaving to get the line in and on deck to get underway. (Conor Minto / U.S. Navy)

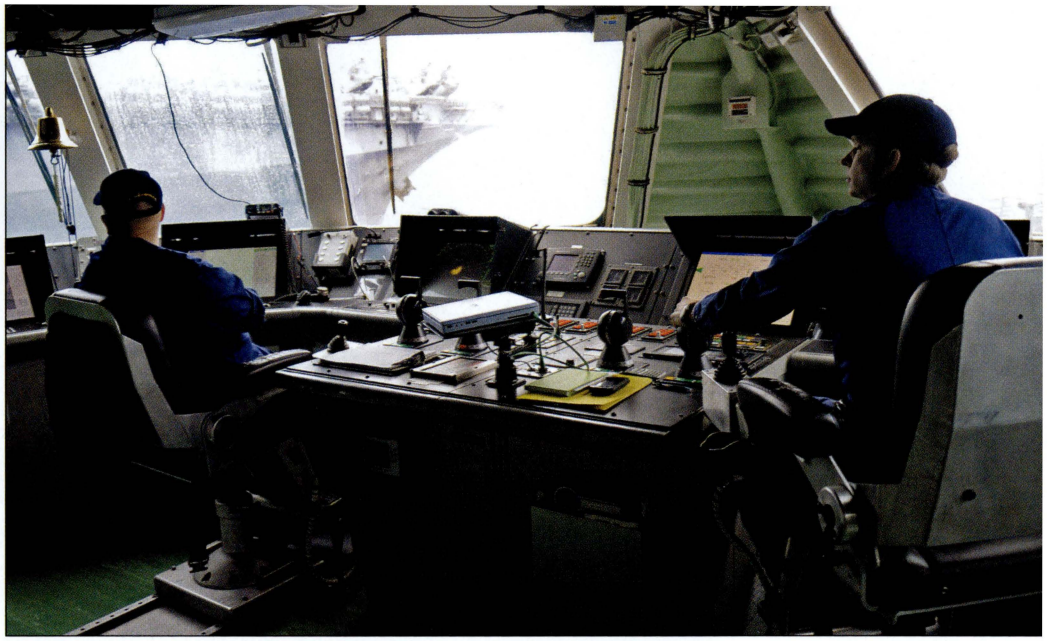
As LCS-1 arrives in Singapore for a port visit, the ship's sign is taken down and polished. Windows, brass fittings, the ship's bell, and hull paint, all need constant care and attention to offset the effects of sun, wind, rain, and salt exposure. Despite technological advances, work details carry on. (Cassandra Thompson / U.S. Navy)

Donning a self-contained breathing apparatus or SCBA is Gunner's Mate 2nd Class Sean Patten. Lending a hand is Chief Information Systems Technician Nicole Ellis. When the fire alarm sounds, everyone has an assigned duty. Teams get ready and attack a fire as soon as possible. (Karolina A. Oseguera / U.S. Navy)

In the mission bay of LCS-2, Senior Chief Damage Controlman Elvis Diaz starts an emergency breathing air compressor (EBAC), to fill an attached composite-wrapped cylinder. Such pressure tanks can be filled to around 3,000 PSI, and provide 15 to 30 minutes of air to a fire fighter. (Trevor Welsh / U.S. Navy)



Inside the housing for the Mk 46 30mm gun on LCS-1, Gunner's Mate 1st Class Galo Hernandez manually adjusts the timing system. These weapons are remotely aimed and fired. This space is not occupied when live-fire drills are underway. Two guns are part of the surface warfare mission package. (Karolina A. Oseguera / U.S. Navy)



Keeping watch on the bridge of LCS-1 during a refueling at sea or RAS is Chief Petty Officer Quartermaster Joseph Radford to the left, with Lt. Adam Beauchene, Officer of the watch, to the right. In this photo an agreed-upon course change by both ships is being initiated. (Lt. Ed Early / U.S. Navy)

While in the South China Sea, Fire Controlman 1st Class Jedediah Lamping aims and fires one of the Mk 46 30mm guns at a target during a live-fire training drill. His display screen shows gun status and rounds remaining, and he can zoom in on the target or out from it, using day or night-vision optics. (Cassandra Thompson / U.S. Navy)

Fuel is being transferred on LCS-2 by Main Propulsion Assistant Lt. Julio Alarcon while in the Caribbean Sea in April of 2012. As fuel is burned, hull trim is changed. By re-distributing remaining fuel, trim can be brought back to normal. The display screen shows fuel tank levels, pumps used and their output. (Trevor Welsh / U.S. Navy)

Aviation Machinist's Mate 2nd Class Daniel Fritz of helicopter maritime strike squadron (HSM)-73 checks a T700 engine on an MH-60R on the flight deck of LCS-1. All of the Navy Seahawk series have two engines and the engine access panel, when opened, serves as a work platform. (Cassandra Thompson / U.S. Navy)

In response to a simulated small boat threat to LCS-1, Electronic Technician Rachel Preston (left), Ensign Kelly Reightler (with camera), and Ensign Charles Hasenbank observe the situation from the bridge wing. As the drill continues, this group can organize appropriate threat solutions. (Cassandra Thompson / U.S. Navy)

A VBSS team member, with simulated injuries, is the subject of a class on how to assess and prepare the victim for medical evacuation or medevac transport. The neck area is immobilized, arms and legs secured for carrying, lifting, and being eventually raised to the deck of LCS-1. (Cassandra Thompson / U.S. Navy)

While in port in Singapore, LCS-1 Hull Maintenance Technician 1st Class Jaime Martinez tightens a valve on a main space drain line for the combining gear lube oil coolers. Maintainers have to know where all vital dynamic components are as well as knowing how to gain access to make repairs. (Cassandra Thompson / U.S. Navy)

While in Singapore on a port call, LCS-3 Boatswain's Mate 2nd Class Manuel Gallegos controls the Launch Recovering and Handling System (LRHS) in the ship's mission bay. The use of such gear moves small craft in and out or to the sides of the docking well quickly with minimal effort by the crew. (Joe Bishop / U.S. Navy)

In the Bay of Bengal, while an MH-60R warms up on the flight deck, a briefing is given to sailors of the Bangladesh Navy during the CARAT 2015 Bangladesh event. The helicopter control station is located at the port aft corner of the superstructure, giving an unobstructed view of the aerial activity. (Joe Bishop / U.S. Navy)

While tied up in the Indian port of Chennai (ex-Madras), Indian Navy, Japanese Mainland Self-Defense Force (JMSDF) and U.S. Navy officers gather in the wardroom of LCS-3 in October 2015 for a briefing in preparation for exercise Malabar 2015. Such meetings aid in mutual agreement on details of future drills. (Joe Bishop / U.S. Navy)

Lieutenant James Stranges of HSM-35, Detachment 3 discusses MQ-8B Fire Scout topics as an Indian Navy officer is briefed on the VTUAV. Blades are folded and sit next to an MH-60 Seahawk in the hangar bay of LCS-3. Red canvas covers protect the main rotor head and engine exhaust outlet. (Joe Bishop / U.S. Navy)

While cruising in the open waters of the South China Sea, a live-fire drill with M-4 assault rifles is undertaken on LCS-3. An ejected brass cartridge flies past the helmet of Gunner's Mate 1st Class Joshua Rhine as he aims with the aid of a laser holographic sight. (Joe Bishop / U.S. Navy)

The Mk 110 57mm gun on LCS-1 is given a thorough pre-fire check while docked in Singapore. Many visual and manual inspections are done as the gun is un-manned when in operation. The gun is aimed and ammunition is fed and loaded from below-decks. (Karolina A. Oseguera / U.S. Navy)

Another live-fire drill is conducted, this time with the M-9 handgun. With safety off and hammer cocked, the 9mm pistol is about to be discharged at a floating target. The weapon can hold up to 15 rounds in each magazine. It is this firearm that replaced the M1911 .45-caliber handgun. (Joe Bishop / U.S. Navy)

An exterior inspection will check the gun barrel, velocimeter, and security of hatches and access panels. After the gun is used, a wooden cleaning rod will be inserted into the barrel to remove soot and residue of spent powder charges. The fluted end of the barrel aids in dispersing gas pressure. (Karolina A. Oseguera / U.S. Navy)

LCS-3 VBSS team members hold a training class for Philippine Navy sailors while on a port call to Puerto Princesa during a CARAT exercise in June 2015. The host nation benefits from learning skills associated with detaining and searching ships as smuggling and human trafficking occur frequently. (Joe Bishop / U.S. Navy)

Surface Warfare Mission Package Detachment 4 VBSS team clears a passageway on LCS-3. The lead man covers the area ahead, while those behind cover the rear, check doors and paths as the team moves forward. During scheduled exercise events, teams will get the chance to drill on vessels of other nations. (Joe Bishop / U.S. Navy)

As a VBSS team gains access to a suspect vessel, members fan out and cover the corners, hatches, and areas above as others climb aboard and take their positions. Once accounted for and ready, a team search of the interior can begin in earnest. Drill evaluators watch the overall progress of a search on LCS-3. (Joe Bishop / U.S. Navy)

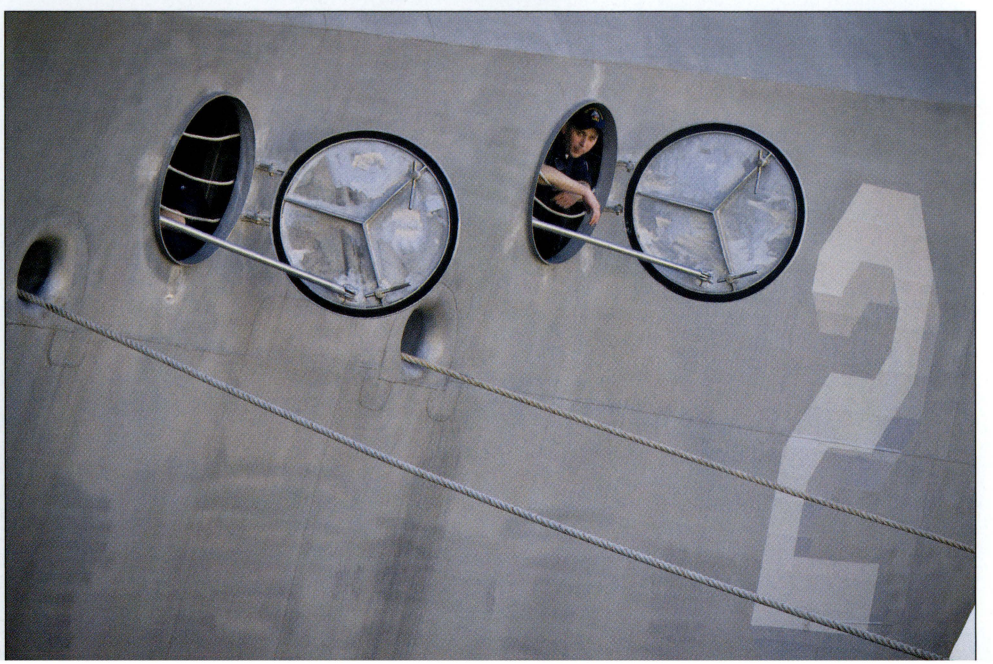
With another VBSS drill over, the team members returns in their RHIB to the well deck of LCS-3. The well deck crew assists in guiding the vessel in and up onto the cradle, the foam-lined stanchions and yellow plastic hull runners are intended to ease the boat in with little or no damage inflicted. (Joe Bishop / U.S. Navy)

LCS-3 makes a port call in Busan, in the Republic of Korea, after the conclusion of the Foal Eagle 2015 exercise. Lines onboard are about to be tossed to the awaiting crewmen on the pier, which has large inflated fenders lashed to its concrete edge to prevent scraping of the ship's hull it is while tied up. (Abraham Essenmacher / U.S. Navy)

As LCS-1 departs San Diego harbor, a deck party retires the jackstaff, by lowering it to a stowed position. This is just one of many steps performed to make ready for sea as power cables, lines and water connections are all brought aboard and put in storage, along with provisions taken on while in port. (Karolina A. Oseguera / U.S. Navy)

As LCS-2 departs Manzanillo, Mexico, in April of 2012, the fenders used to protect the aft hull are hauled back aboard. Safety measures include here a safety harness on the crewman handling the fender and another holding the line to which the fender is tied. (Trevor Welsh / U.S. Navy)

In Mayport, Florida, in April 2010, an LCS-2 crewman gazes ashore through an open porthole along the starboard side. Round hatches have dual hinges, rubber seals and two securing latches, plus safety lines across the opening to prevent people or objects from falling overboard. (Gary Granger / U.S. Navy)



As night falls over the South China Sea, LCS-3 closes on T-AKE8 USNS *Wally Schirra* of the *Lewis and Clark*-class of dry cargo/ammunition ships. The ship is named after one of the original seven Mercury Program Astronauts. Night-time replenishment occurs as frequently as daytime operations. (Conor Minto / U.S. Navy)

T-AO 200 USNS *Guadalupe* conducts a dual underway replenishment of LHD-8 *Makin Island* to the right, with LCS-2 at left. LHD-8 is of the *Wasp*-class of amphibious assault ships. T-AO 200 carries 86,400 barrels of oil and 54,000 barrels of JP-5 used as aviation fuel. (Kory Alsberry / U.S. Navy)

Wally Schirra maintains speed and distance with LCS-3. These cargo ships can carry up to 6,675 metric tons of dry cargo, 23,450 barrels of fuel, and 200 metric tons of potable water. Full load displacement is 42,528 metric tons. Her crew complement of 135 is made up of 11 Naval and 124 civil service mariners. (Conor Minto / U.S. Navy)

LCS-2 *Independence* is shown in formation with the Mexican Navy Frigate F 202 *Hermenegildo Galeana*. Her past service was with the U.S. Navy, as the former FF 1037 *Bronstein*. Both ships are seen here conducting a passing exercise in which one ship overtakes the other. (Trevor Welsh / U.S. Navy)

The calm Pacific Ocean in July 2014 makes a dramatic seascape for a photo opportunity with the ships (left to right) LPD-23 *Anchorage*, LCS-4 *Coronado*, the joint high speed vessel or JHSV-3 USNS *Millinocket* (ex-*Fortitude*), and the mobile landing platform MLP-1 USNS *Montford Point*. In the modern United States Navy all of these ships have vital and specific roles to play, from amphibious landing support, to transporting vessels, cargo and material, to high speed transit to zones of conflict and conducting operations once there, to intra-theater transport of ground troops and vehicles. All of these vessels have been created from an initial set of requirements and needs. (Mark Schultz / U.S. Navy)

Kyle Kiner and his wife embrace as Crew 102 of LCS-1 arrives back in San Diego from Singapore. Homecoming events are as much a part of Navy tradition as leaving port and tours of sea duty. E-mail and video messaging have done much to ease the strain of families adapting to the Navy way of life. (Daniel M. Young / U.S. Navy)

While docked in Singapore in July of 2013, sailors are greeted by the Vice President of the United States, Joe Biden, who praises them for their service to the nation. Such visits boost morale and let the service men and women know they are supported at the highest levels of the government. (Gerald Dudley Reynolds / U.S. Navy)

Electronic Technician Jason Luke shares a moment with his wife Kim and Son after arriving back in San Diego from the maiden deployment of LCS-1. Shore leave and training as ship systems are upgraded will culminate in yet another period of time spent away at sea. (Katarzyna Kobiljak / U.S. Navy)

The crew of LCS-4 runs aboard their ship at the call to "Bring the ship alive." The enthusiasm and encouragement by families attending the ceremony are an old Navy tradition. The crew will stand along the railings as the horn sounds, steam vents from the stacks, and the first watch is posted. (Gerald Dudley Reynolds / U.S. Navy)

LCS-3 *Fort Worth* cruises in Lake Michigan during builder's trials in October of 2011. LCS is a major departure in the way the United States Navy procures, builds, and operates warships. They will be increasingly relied upon to respond to littoral conflicts with speed, agility, and have the means by which to neutralize hostile air, surface, and underwater dangers not only to themselves, but to keep other ships safe as they act out their roles in any future maritime battles. After all the praise, criticism, and assurances, the only real test will be in the heat of combat. If and when a post-conflict critique is written, assessments will be made and evaluated and lessons learned and applied. At that time we will know how effective and useful the Littoral Combat Ship truly is. The historical accounts of many naval vessels end with the observation that it was never used in wartime. The very presence and unspoken message they sent was enough to prevent an engagement of opposing naval forces. It is hoped that the LCS class will be remembered in this way as well. (Michael Rote / U.S. Navy)

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